FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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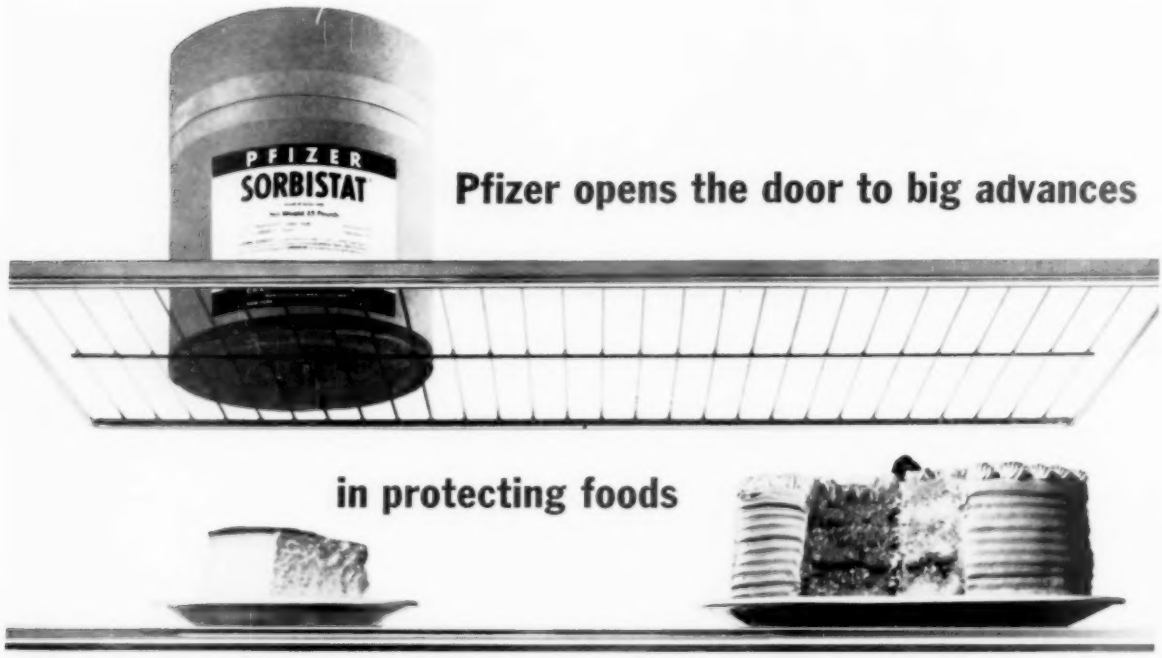

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IFT REGIONAL SECTIONS . . .

SPEECHES, SPECIAL EVENTS, NEWS NOTES

Education—Business or Pleasure?

The Phi Tau Sigma Address*

C. Olin Ball
Department of Food Technology
Rutgers University
New Brunswick, New Jersey

THERE IS A DEARTH of young people being trained in the field of food technology. There is particularly a dearth of young people of superior ability being trained in food technology. These things we know to be true.

One of the main reasons for the existence of this situation is a shunning of scientific and engineering training by students—which seems to be becoming more prevalent as time goes on. Many people, among whom is the writer, feel that a strong trend toward a permissive attitude of parents toward their offspring since World War II, or, perhaps, before World War II, has been largely responsible for an unwillingness of young people to appreciate and accept the responsibilities encumbent upon them to equip themselves mentally to carry on their life's work.

There appears to be also a serious shortage of teachers capable of conducting scientific courses in the secondary schools. This is probably due, at least in part, to the same factors that brought about the dearth in students studying science and mathematics.

This situation, as we all know, is not unique to the field of food technology. It is common to all lines of scientific and technical activity. The remedy appears to lie in three steps, namely, (1) to instill in students a sense of their full responsibility to themselves and to society, as well as an adequate understanding of the true meaning of education, (2) to arouse in them an acute interest in the attainment of an education within that meaning, and (3) to make the attainment of that education interesting.

The first step appears to be partially outside the sphere of Phi Tau Sigma activities. However, the society certainly can help to create an understanding by students of the meaning of education.

It is believed that the second and third steps can best be accomplished by the use of incentives, plus the providing of high grade instruction and guidance for students. Honors constitute one type of incentive. This type is signified by membership in Phi Tau Sigma. Our society, however, should probably not limit its interest in incentives to the category of honors. After all, there is no complete substitute for money as an incentive to intensive effort. Monetary emoluments to assist students to obtain an education, which include scholarships and fellowships, as well as proper facilities for the educational institutions and adequate pay for those who teach the students, plus proper vocational pay for the graduate who has done a good job in the University should all claim an interest on the part of Phi Tau Sigma. The society should endeavor to create interest in promoting the aims we have mentioned on the part of potential donors of monetary assistance.

Definitely, one way not to do this job would be to encourage the lowering of scholastic standards in the Univerities. A watering down of standards of educational curricula may have the effect of increasing the number of students but, at the same time, it cannot avoid lowering the quality of the results. Only students of below average quality are likely to be attracted by watered-down curricula.

OBJECTIVES OF EDUCATION

The answer to the question as to whether or not Food Technology students should be separated into more than one category from the standpoint of curriculum depends upon what is the object of the education. Is it to develop judgment and powers of observation and analysis or to help the student to memorize procedures? Is the person who is not to be trained for research to be trained for production work, quality control, administration, sales, engineering, or is he to be given his choice by making six curricula instead of one available to him? From the standpoint of types of training, it is as logical and as desirable to offer six curricula as it is to offer two. There is just as much difference between production work and sales work, for instance, as there is between production work and research work.

Because of the increasing complexity of vocational activity, memory for facts is becoming of less and less importance because few problems today are solved through the remembrance of facts. To solve a complex problem, it is necessary to depend upon many sources for the facts required. Wisdom in the use of facts is the essential attribute for the solving of problems in the complex life of today. No one is wise enough to decide what factual information should be stored in the mind today in order to be prepared to solve the problems of tomorrow. So-called "modern" educational methods in the lower grades seem to overstress the importance of memory. Even in Chemistry and Physics instruction, not of the "modern" type, it seems within reason to ask how important is it to remember who first promulgated Boyle's Law, Carter's Law, or Avogadro's Hypothesis.

Returning to the question of two curricula in FOOD TECHNOLOGY, we wonder, if a student completed a tangent curriculum, that is, an off-shoot from a basic curriculum in Food Technology, in what way would he be better prepared to fill a job in production, administration, sales, quality control, or engineering than he would be if he completed a basic curriculum? The real idea back of the movement in favor of two curricula

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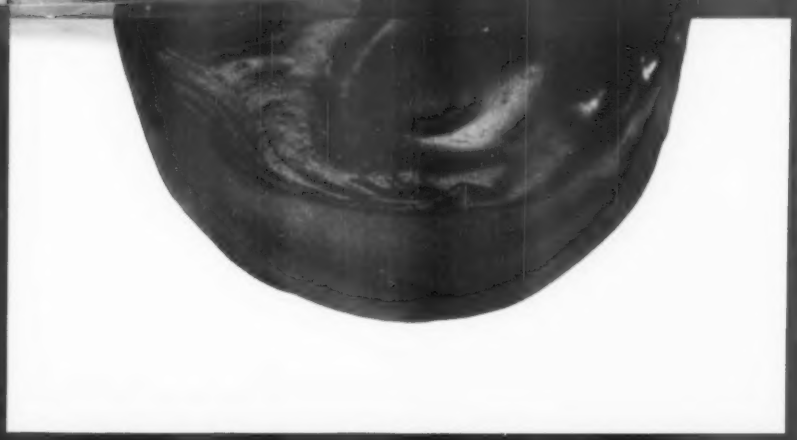
* Presented in part at the meeting of Phi Tau Sigma, St. Louis, Missouri, held during the Sixteenth Annual Meeting of the Institute of Food Technologists in June 1956.



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The Vital Story of VITAMIN A

by Science Writer

We live in a golden age of the sciences!

In the science of nutrition discoveries of food elements and their action have resulted in the promise of better health for us all.

Let's consider vitamin A as an example.

A Capsule History. 1913 was the year. Two teams working independently with animal feeding experiments discovered that a diet which was good in all other respects but which varied only in the source of fat caused young animals to thrive or sicken as the fat was varied. The work of these teams (McCollum and Davis; Osborne and Mendel) led to the discovery of the food factor which we know as vitamin A.

Composition and Action. A pale yellow, oil-soluble substance, vitamin A is expressed in the chemist's shorthand as $C_{20}H_{29}OH$. It is necessary in the diets of men and animals to promote the body's growth and development. Vitamin A is a vital requirement in guarding the health of the eyes and skin, and for resistance against infection. It helps maintain the health of mucous membranes and other specialized epithelial and glandular tissues.

Vitamin A enters the body as a constituent of food. Or it may be created within the body when a precursor of vitamin A is eaten. A precursor is a food element with potential vitamin A *value* but no actual vitamin A *content*. For instance, many green leaves have a high vitamin A value but, paradoxically, contain no actual vitamin A. The body converts the precursor into the vitamin. The most common precursor of vitamin A is beta carotene, the natural yellow coloring of many foods, such as dairy products, cereal grains, carrots, alfalfa, etc.

When consumed in food vitamin A is absorbed primarily in the healthy intestine, is esterified in the intestine's walls and is carried as an ester in the lymph and blood to the body's storage depots. The liver, which has a large capacity for storage, contains about 90% of the vitamin A found in the body.

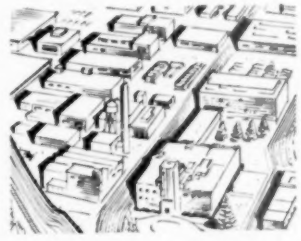
Isolation and Synthesis. It was not until 1937 that pure, crystalline vitamin A was isolated by Holmes and Corbett from fish-liver oil. Research in the synthesis of vitamin A was stimulated during the Second World War by the threat to natural sources in fish-liver oil. This work resulted in several processes to produce vitamin A synthetically. Of these, one of the most successful was evolved by the Roche research team headed by Dr. Otto Isler which was announced in 1947. Much of the vitamin A now used for pharmaceutical manufacturing and food fortification in the United States and many other countries of the world is produced by this process.

Vitamin A and beta carotene produced by the Hoffmann-La Roche synthesis have many positive advantages for food and pharmaceutical manufacturers. Among these are the complete absence of any "fishy" odor, taste, or after-taste; the reasonable and stable price; their stability, purity and uniformity and the assurance of a steady economical supply.

Vitamin A is described in the U. S. Pharmacopoeia as a fully acceptable compound for use in pharmaceutical products. The U. S. Food and Drug Administration has approved its use for the fortification of margarine and other foods.

Human Requirements. The Food & Nutrition Board of the National Research Council recommends that a daily allowance of 5000 International Units of vitamin A in the diet will maintain good nutrition of healthy adults in the U.S.A. The Board's recommendations vary above this for pregnant and lactating women, and below for infants and children. The adult dose used in therapy may vary from 50,000 to 200,000 units daily.

Production. At the huge Roche Park plant of Hoffmann-La Roche in Nutley, New Jersey, over 500 pieces of large-scale chemical engineering equipment are working constantly to produce the superior 'Roche' vitamin A. This production is so large that 'Roche' vitamin A comes from the plant actually by the tons. In fact, the entire needs of the food and pharmaceutical industries of the United States and Canada can be met from this one plant.



Again the Roche people, who have so often led the way in vitamin research and production, have made another contribution to the better health and well-being of countless millions.

This article is one of a series giving a brief resume of our present knowledge of those essential health factors—the vitamins. Reprints of this and other articles are available without charge. The Vital Story of Vitamin C was published previously and others are forthcoming. Send your request to: Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul St., W.; Montreal, Quebec.

FOOD TECHNOLOGY

Published Monthly by the Institute of Food Technologists

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Address to the business office all requests for subscriptions, changes of address, and information on advertising. Claims for copies lost in the mails must be received 30 days after issue (90 days, foreign). Changes of address must be received at least two weeks before date of issue.

Subscription Rates: For members the cost of subscription is included in the annual dues. Non-members: domestic, $8.50 per year; Canada, Cuba and Mexico, $10.00 per year; all other foreign, $12.00 per year. Single and back copies: domestic, $1.50; foreign, $1.75.

Advertising Representatives: *Eastern:* Duncan Macpherson, 126 Summit Avenue, Jenkintown, Pa. *Midwestern:* Dale McCutcheon & Co., 154 E. Erie Street, Chicago 11, Illinois. *West Coast:* William A. Ayres Company, 233 Sansome Street, San Francisco 4, California.

Publication Office

The Garrard Press

119 West Park Avenue, Champaign, Illinois

Address to the Publication Office all requests for non-member subscriptions, back volumes, single copies (costs are listed above). Authors desiring reprints should address orders to this office; rates are printed on the order blank. (Requests for a single reprint of a published paper should be addressed to the author.)

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by the Garrard Press, Champaign, Illinois, U. S. A.

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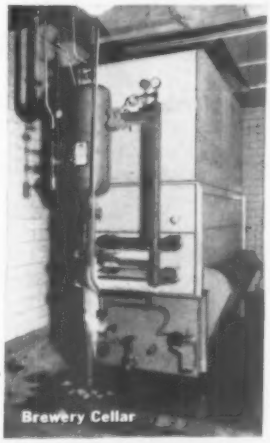
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(Continued from page 2)

appears to be simply to take pressure off the student who does not want to exert himself sufficently to get the kind of training that a B.S. degree implies he has had. The basic idea is not to give this student a different type of training than that received by the man who intends to go into research work.

The man who is going to do research work in Food Technology does not actually need any undergraduate courses of a specialized nature from a Food Technology curriculum. Neither does the man who is going into production or adminstration. It makes little difference in what specialty a student gains knowledge of and experience with principles involved in a unit process or a unit operation. In fact, it is perhaps the best type of training for one to get his first knowledge of such an operation or process in a different field from that in which he expects to apply it. His comprehension of its usefulness, as well as of its manner of usage, should be broadened thereby. This statement is not intended to imply that it is never desirable for the Food Technology student to obtain his knowledge of a unit operation or a unit process through study of an application in the food industry. It simply is not very important which way is chosen.

I was interested to read in *Fortune Magazine* recently a carefully weighed opinion that, if present trends continue, the typical non-specialist will be earning more after he has been on the job for 5 to 10 years than the typical specialist. But, initially, the non-specialist is less sought after than the specialist, indicating a false appraisal by employers of the specialized knowledge gained in the specialized curriculum by the employee. Such a misappraisal by prospective employers seems rather common.

Two curricula for the same degree might be justified if each required the same amount of effort on the part of the student. Courses which present a lot of problems to be solved or a lot of original compositions to be written require more of the student's time and brain exercise per credit hour allowed than courses which have no such requirements. Either, more credit hours should be required in the curricula that do not present problems of the intricacy of those of mathematics, physics, or engineering or more classroom hours per hour of credit allowed should be required than in the curricula that present such problems. Unwillingness to accept such a plan must be interpreted as evidence that the basic idea of the multiple curriculum plan is to provide an easier way to a degree for the student who does not choose to train himself in such a way as to develop analytical skill.

Every occupation presents problems, the solving of which must depend upon the understanding of the worker. When a problem becomes routine, however, it no longer constitutes a problem because it is handled in a routine manner. When I do a piece of carpentry or of masonry, I can do it just as well as a trained carpenter or mason with identical tools. But it may take me 3 or 4 times as long as it takes him because I have to solve, as I go along, problems which have become routine to the experienced worker.

The very common practice of referring to education as a means of acquiring knowledge or information is to be roundly condemned. It is understanding, or wisdom, the development of which is the true objective of education, that enables one to solve problems, simple or complex. Even vocational training develops understanding. Vocational training at the carpenter or machinist level, however, is taken by the person who either does not have the capability or does not have the will to acquire a degree of understanding of principles which would enable him to master the more complex problems such as one encounters in the engineering, physics, or chemistry laboratory. All laboratory work is vocational training but the levels of sophistication required in the scientific laboratory are different from those required in the manual training school. All laboratory courses provide training in manual dexterity plus a demonstration of principles. The distinction between the various levels of laboratory training is to be found primarily in differences between the intellectual levels of the workers, not in fundamental differences in the nature of the work. Brilliant workers in a manual training workshop, with proper incentive and proper guidance, would raise the level of quality of work in the workshop to that of the engineering, physics, or chemistry laboratory.

In 1955, graduates of Harvard Business School with engineering training received an average starting salary of $6,100; those without engineering training $5,200. It would probably be wrong to reason that the higher salary for the man with engineering training came because of the knowledge acquired by the engineer compared to that acquired by the non-engineer. While it may not be true, it certainly would be logical for this difference in salary to be due to difference in the basic nature of the men, as indicated by the fact that some took engineering and some did not. The man who is willing to take engineering training and has the guts to complete it has some basic quality which is desired by employers and which the other man presumably does not have. Many employers choose an employee according to the branch of his collegiate training without knowing why. They overlook the fact that what a man is really determines what the man studies more than what he studies determines what he is.

The extra value of the person with engineering training lies, not in his engineering knowledge, which will probably never be used in his vocation, but in his type of thinking. The reason for the preference for the engineering student is that chances of a successful career, in business or elsewhere, are greater for the person whose thinking follows the scientific pattern, regardless of whether the occupation is in administration, production, research, or distribution. This is the type of thinking that emphasizes the why of an action more than the how of it.

FACTUAL INFORMATION SHOULD NOT BE THE GOAL

The fact that elaborate indoctrination in a job is necessary for all graduates indicates how unimportant are the items of factual information which the graduate

(Continued on page 8)

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(Continued from page 6)

carries with him out of college. I.B.M. spends between $8,000 and $10,000 on a computer salesman before he goes out to make a sale.

With all the evidence that is piling up mountain high that it is a pursuit of a will-o'-the-wisp to continue to search for courses of study which will give factual information that is worth acquiring as part of training for life's work, the evidence continues to be ignored and the search for such curricula continues unabated. It has been said that the 30 or so short courses for training of executives which have sprung up in our universities since 1950 "are designed to teach people what they are already paid for knowing." That may be true in a sense, but it is questionable whether either the business executives or the university faculties realize that it is not factual information that the executives need but understanding to enable them to know what to do with factual information when they have to use it in arriving at decisions. It is the same in all lines of activity. The training needed is that which develops discrimination in logic to the point (to use legal phraseology) of enabling the trainee to recognize a preponderance of evidence. Besides being able to recognize and interpret experimental evidence, he should be able to do what he is supposed to have been taught in grammar school to do, namely, to analyze a sentence and be able to get from it its true meaning as well as be able to put into it an intended meaning. Many employers are greatly impressed by fluency on the part of a prospective employee in discussing memorized facts about his specialty. The memorized facts may be chemical formulas or descriptions of economic principles. The multiplication of the number of executives short courses, however, signalizes a gradual realization by management personnel, that an executive needs more than a "union card" to qualify for his position.

". . . WITH ALL THY GETTING—GET UNDERSTANDING"

In the above picture we have tried to present the objectives of education and, despite the reticence of many liberal arts advocates to accept the idea, the degree to which these objectives are attained is proportional to the degree to which the scientific pattern of thinking is developed. The pursuit of "well-rounded" training by following the liberal arts pattern of training accomplishes its intended purpose only when the student is provided with a basis for analyzing the thoughts of people of former times and for comparing their significance with that of the thoughts of contemporary people. Properly directed study of literature, history, and philosophy develops judgment. The conditions surrounding the earlier people determined their habits of thought. When one studies the humanities, he should realize that he is studying the natural science of the past. The origin of natural science was the origin of religion. At that time, religion, science, and philosophy were identical. Religious dogma expressed the knowledge of science in the form of religious precepts, calling for the kind of behavior by the individual which was calculated to apply scientific principles in a manner which would be best for his physical welfare. Both science and religion were supernatural. As time went on, an artificial distinction grew up between science and religion because it was believed that, as science assumed a natural aspect, it had to be separated from religion which, because it originated in the supernatural realm, should continue to be supernatural. Thus, natural science was removed from the category of the humanities, where it originated and where it probably belongs. The gulf between *science* and the *humanities* has tended to broaden in the minds of people but no one seems to be sure as to just what the two terms, respectively, include. That is not a surprising fact since a definitive separation certainly is not easy to make.

Study of the humanities purely for the purpose of attaining an emotional appreciation of the arts is a specious, and, one might justifiably say, a selfish thing. A worthy purpose is to stimulate creative talent in the arts or in the social sciences.

Our President, Mr. Eisenhower, is referred to in some quarters as being one of our "know-nothing" Presidents because he is said to do practically no reading except of western stories. He is said not even to be a student of history, which is considered to be almost an unpardonable sin for a President. It is amazing what can be accomplished by one who has not attempted to plaster the walls of his mind with a maze of factual information which would probably serve only to help him make an impression as a conversationalist.

Pasteur is considered to have been a cultured gentleman. His biographers say he went to the theatre, including opera, probably not more than a dozen times in his life and his intense opposition to the building of the elaborate Paris Opera House when laboratories were so badly needed, which would have been godsends to the physical well-being of the people, is well known. Perhaps these facts are nothing about which to make a fuss. Their mere mention could lead to an interminable discussion as to the definition of culture. Nevertheless, there is a thought-provoking significance in them.

THE WELL-ROUNDED INDIVIDUAL

Among the things to which I think Phi Tau Sigma should address itself is the term "well-rounded individual." Like the word "culture," this term is tossed about promiscuously and with a recklessness that is nothing short of appalling. From an editorial I read a couple months ago, I quote as follows "Over 55% of all university graduates in Russia are either engineers, scientists, or mathematicians." Just ahead of that, I read, "They (the Russian Universities) are not interested in higher education producing a cultured and well-rounded individual." Draw your own inference. I do not know the facts but I question the wisdom of reaching a conclusion so tritely.

In the same paper, a couple of weeks later, I read in an editorial this statement, "We can't apply, to the situation of the 60's, the employment and education policies appropriate to the 50's and 40's." To that I agree—with some exceptions. For instance, we would be better off if some of the education policies of the 10's

(Continued on page 12)

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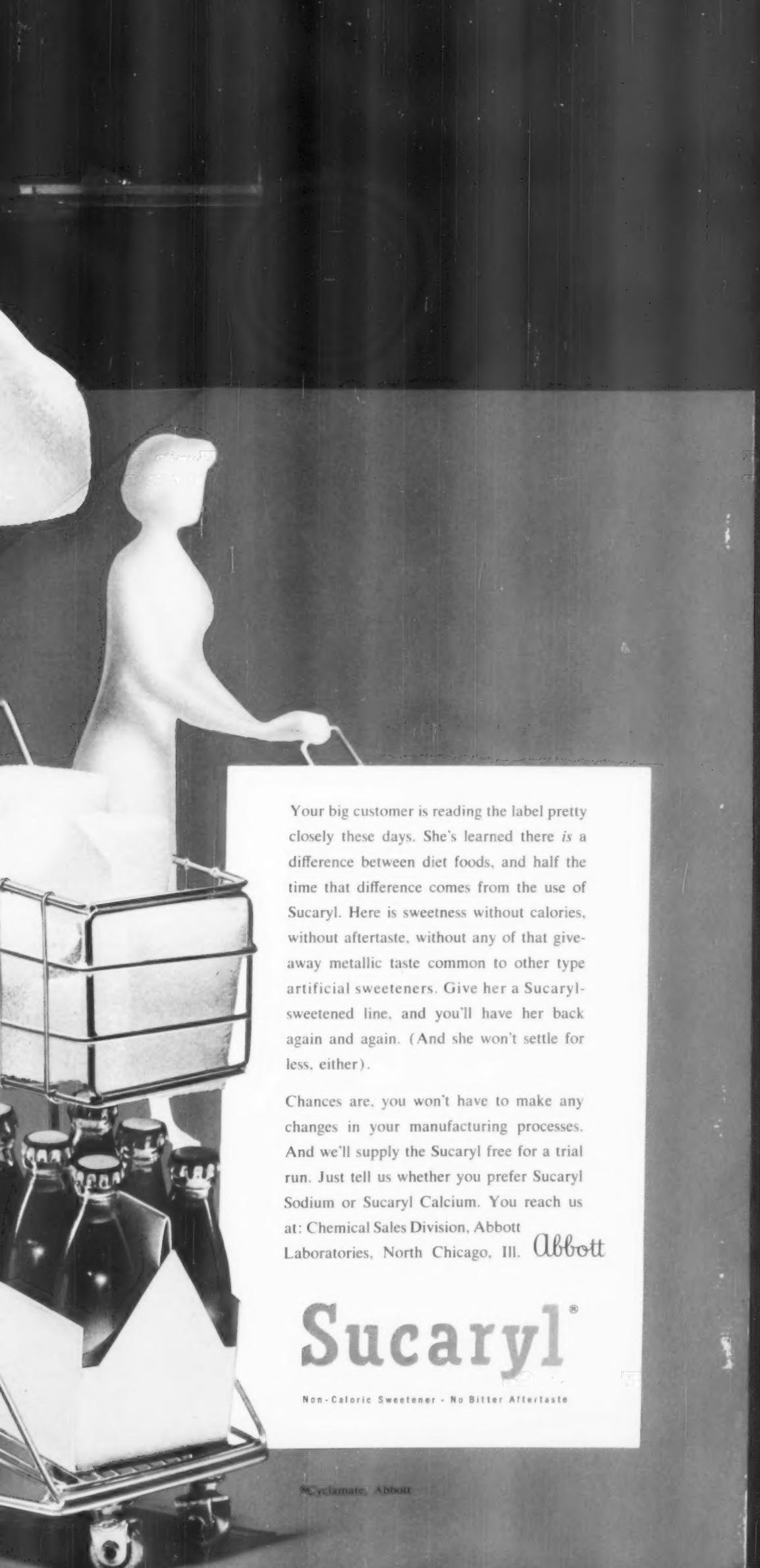

Your big customer is reading the label pretty closely these days. She's learned there *is* a difference between diet foods, and half the time that difference comes from the use of Sucaryl. Here is sweetness without calories, without aftertaste, without any of that give-away metallic taste common to other type artificial sweeteners. Give her a Sucaryl-sweetened line, and you'll have her back again and again. (And she won't settle for less, either).

Chances are, you won't have to make any changes in your manufacturing processes. And we'll supply the Sucaryl free for a trial run. Just tell us whether you prefer Sucaryl Sodium or Sucaryl Calcium. You reach us at: Chemical Sales Division, Abbott Laboratories, North Chicago, Ill. Abbott

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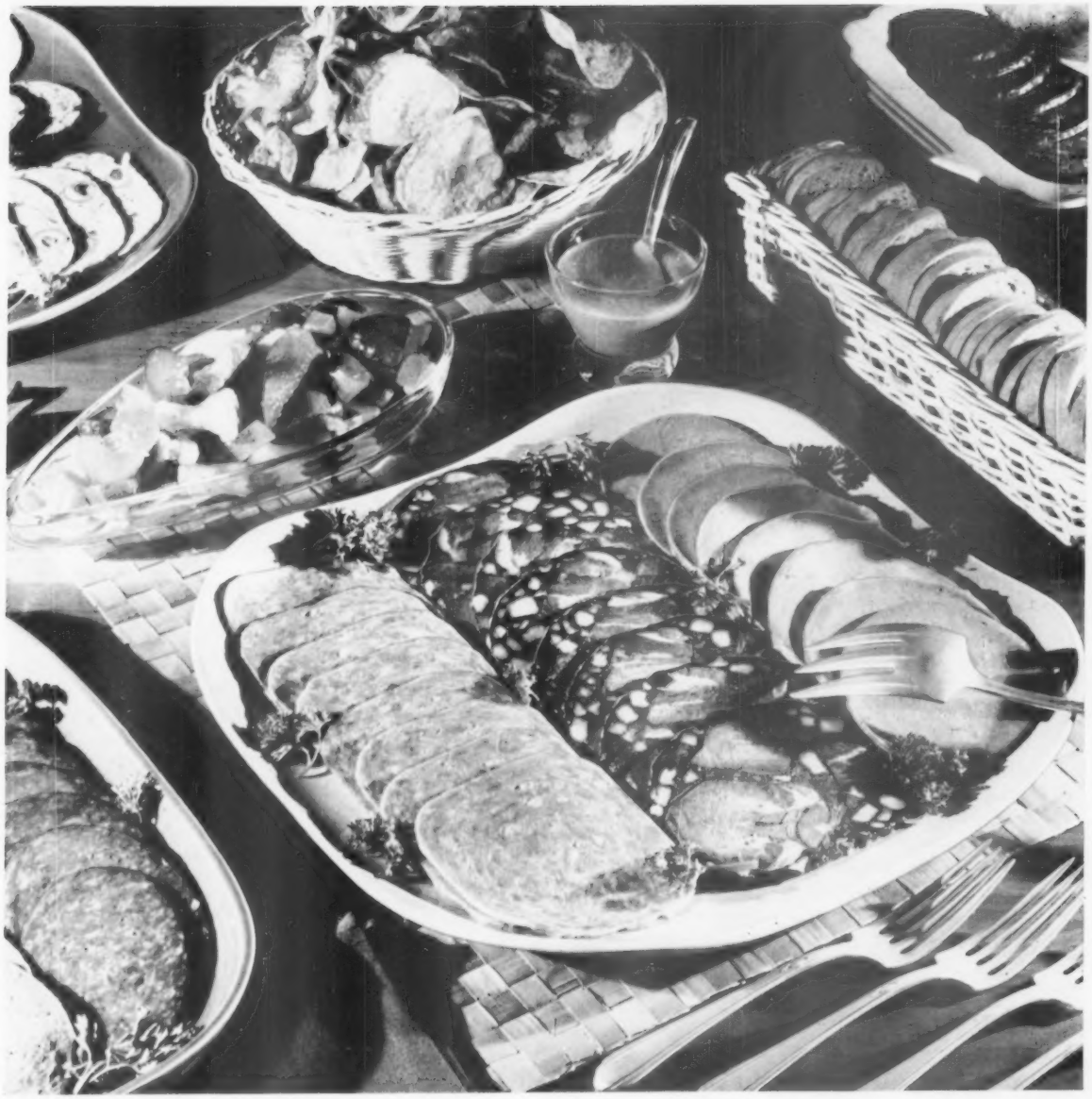

ONLY "CONTROLLED" SEASONING can assure you an *economical, easy-to-employ, absolutely dependable* method of producing fine, uniform flavoring effects of any desired character for prepared meat, food or other flavoring purposes. We shall be glad to tell you more about FRITZSCHE'S "CONTROLLED" SEASONING BLENDS if you'll write us... Remember: *Your product is* ONLY *as good as its* FLAVOR!

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(Continued from page 8)

and 20's, which seem now to be all but abandoned, were resurrected with force. When we stop to think that half of the high schools in the United States teach not a single course in physics or chemistry and that the teachers in mathematics and science of hundreds of thousands of pupils who are supposed to be getting training in these subjects are not qualified to teach the subjects, one begins to appreciate the mass corrective measures that are needed. We have many reasons to be alarmed over comparative American and Russian statistics when we are told that the number of engineering graduates from Soviet higher institutions increased from less than 30,000 in 1950 to more than 60,000 in 1955 while, during the same period, our own graduates decreased in number from about 50,000 to 23,000. High school statistics leading up to the beginning of this period (1950) also are interesting. I am indebted to a report on an address by Admiral H. G. Rickover, Chief of the Naval Reactors Branch of the A. E. C., for the following tabulation of percentages of high school students studying scientific subjects in 1950 and in 1900.

	Percentage Studying in 1900	1950
Physics	23	4
Chemistry	15	7
Algebra	52	27
Geometry	27	13

ATTITUDES MUST BE CHANGED

I have tried to present pertinent aspects of the problems which Phi Tau Sigma faces—aspects which need to be kept within our vision as we undertake our task. Before success can be attained, mental attitudes, not only of the young folks but also of many, many adults—parents and educators alike—must be changed. Toleration of the elimination of the real mental muscle building courses, not only of mathetmatics and the sciences, but of the classics, as well, in our secondary schools must come to an end and these branches of study must be restored to greater prominence than ever before.

Reason for a bit of encouragement, perhaps, can be found in a report that, on methods of child-rearing, the pendulum shows signs of swinging back. Psychologists are said to be losing some of their regard for the permissive attitude and acquiring favor for the attitude of more discipline. Self-discipline is a requirement to obtaining an education under the definition which I have tried to present herein. Self-discipline is not miscible with contentment to sit around watching spectator sports and TV and letting others do the thinking. Nor is it likely to show much strength in the increasing hundreds of students who are streaming into colleges for social and athletic reasons.

MOHAWK VALLEY . . . .

On June 7, 1956, members of the Section met at Chr. Hansen Laboratories, Little Falls, New York, for the monthly meeting.

Color slides showing the nuclear tests on canned foods were presented by Mr. E. J. Abeling, through the courtesy of the National Canners Association. A general discussoin period and refreshments followed the showing of the slides.

On July 19, the members were guests of the Beech-Nut Packing Company at Wintergreen Park, Canajoharie, New York, for the annual Section picnic. A picnic supper was served, followed by a most enjoyable social evening.

NORTHERN CALIFORNIA . . . .

Walter Landor of Walter Landor and Associates, San Francisco, addressed the Section's June 21st meeting on the subject of "The Power of the Package—how design can set the pace of advertising and selling." The dinner was held in the International Room of the Oakland Airport. In the afternoon, the first Northern California IFT Golf Tournament was held at the Castlewood Country Club.

PERSONNEL

Dr. Ellery H. Harvey, past president of the Institute and founder of the Association of Research Directors, has just returned from a year in Mexico studying the technical man-power problems of the food industry. The research, requested by the Bank of Mexico, was sponsored by the International Cooperation Administration of the U. S. State Department. While in Mexico, Dr. Harvey initiated plans for the formation of a Mexican Section of the Institute.

Dr. Robert A. Bottomley, research superintendent of Mauri Brothers and Thomson Limited, Sydney, N.S.W. Australia, has been re-appointed to the Food Additives and Food Standards Sub-committees of the Australian National Health and Medical Research Council. Dr. Bottomley, a member of IFT, is a graduate in agricultural biochemistry of the University of Minnesota.

Professor Edward Ross is presently at the University of Hawaii College of Agriculture, Honolulu, on a sabbatical leave of six months from the State College of Washington at Pullman. He is at work on enzyme problems in tropical fruits and is located at the excellently equipped Food Processing Laboratory which has unusual laboratory and pilot plant facilities for tropical fruit processing studies.

COMPLETE FILE OF FOOD RESEARCH AVAILABLE

Professor Jessie Whitacre, Department of Rural Home Research, Texas Agricultural Experiment Station, College Station, Texas, is offering for sale a complete file of *Food Research*, volume 1-21 (1936-56). Anyone interested should negotiate directly with Professor Whitacre.

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ANNUAL MEETING ANNOUNCEMENTS . . .

PROGRAM FOR THE SEVENTEENTH ANNUAL MEETING OF IFT IN PITTSBURGH, MAY 12-16, 1957

Announced by Program Committee Co-Chairmen

A WELL-ROUNDED PROGRAM that proportions the diverse subject matter of food research and technology into interesting and intelligible units is the product of the Pittsburgh meeting Program Committee. Co-chairmen R. E. Buck and C. R. Stumbo have just released the titles of the sessions and the respective leaders.

Co-chairmen, Pittsburgh-in-'57 meeting—
(L) R. E. Buck and (R) C. R. Stumbo

The technical part of the Seventeenth Annual Meeting will open with a GENERAL SESSION, the leader for which will be announced later.

The PACKAGING SESSION, with emphasis on flexible packaging, will be conducted under the leadership of Mr. P. B. Reuman, Standard Packaging Corporation, 629 Grove Street, Jersey City 2, N. J. Mr. Reuman is Director of Research and Development for Standard Packaging.

Paul B. Reuman will preside over the session on packaging at the "Pittsburgh in '57" IFT Meeting.

Papers reporting research and technological investigations on MEAT AND FISH will be presented at a session to be led by Dr. Hugh L. A. Tarr of the Fisheries Experimental Station, 898 Richards Street, Vancouver, B. C. Dr. Tarr, an Associate Editor of *Food Research*, has long been active in research on fisheries products.

H. L. A. Tarr—Meat and Fish Session

W. F. Talburt—
Dehydration Session

DEHYDRATION studies will be presented at a session presided over by W. F. Talburt, head, Vegetable Section, Western Utilization Research Branch, Agricultural Research Service, the laboratories of the U. S. Department of Agriculture located at 800 Buchanan Street, Albany 10, California. Marked progress has been made in dehydration in recent years and the dubious reputation of dehydrated foods during World War II years has been virtually erased.

FOOD PRESERVATION, a session to be led by Dr. W. B. Esselen, Department of Food Technology, University of Massachusetts, Amherst, Massachusetts, is divided into four subsessions. They are: heat, radiation, fermentation, and antibiotics. This session maintains a nice balance among the standard and the experimental forms of food preservation.

W. B. Esselen—Food
Preservation

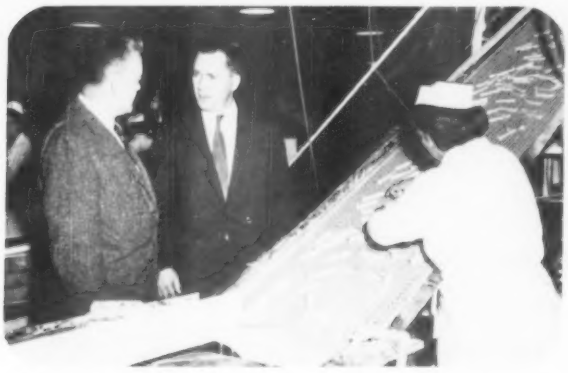
(Continued on page 16)

4 Fishermen

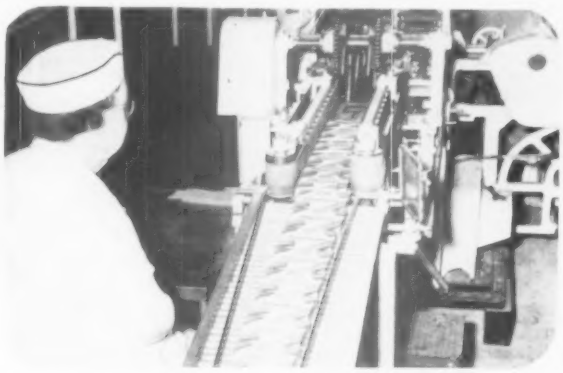
how 4 Fishermen made a big haul with Ac'cent

The Fulham Brothers beam as sales of 4 Fishermen pre-cooked frozen fishsticks continue their upward surge. Sales are up 85% since 1954. Even higher volume is predicted for the future.

Trawler off the coast of Maine. Mr. John Fulham has estimated that over four-fifths of North Atlantic sea foods will reach the consumer in pre-cooked form by 1960.



Ac'cent holds natural flavor. An extra 4 ounces of Ac'cent are added to each 18 lbs. of batter, in addition to the Ac'cent the prepared breading and batter already contains.



Packaged and ready for market! Processors of both canned and frozen foods have found that Ac'cent gives their products a competitive edge on flavor to build brand preference.

Business up 85% in 2 years

THE four smiling faces on the 4 Fishermen package are reflected many times in the sales department of Fulham Brothers, of Boston and Portland. Sales of their frozen fish sticks have been climbing in an amazing fashion since their introduction in 1954.

One contributing reason is the use of Ac'cent, to build and hold the fresh-caught ocean flavor of the cod and haddock. Fulham Brothers buys prepared batter and breading containing Ac'cent. For a final measure of flavor insurance, they also add 4 ounces of Ac'cent to every 18 pounds of batter to insure consumers of the finest flavor and to promote repeat business for 4 Fishermen.

Simply by adding Ac'cent, hundreds of leading food processors give their products a competitive edge on flavor. Ac'cent heightens and holds true food flavors, and guards against flavor loss in packing, shipping and storage.

Isn't the precious flavor of *your* products worth protecting with Ac'cent? Ac'cent is readily available from local warehouses, and Ac'cent technical representatives will aid you in determining the amount best suited for your product. Call or write today to

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(Continued from page 14)

K. G. Dykstra—Frozen Foods

FROZEN FOODS will come in for their full share of attention at a session headed by Dr. K. G. Dykstra, Birdseye Division, General Foods Corporation, 162 South Main Street, Albion, New York. Dr. Dykstra is Director of Laboratories for the Birdseye Division. The technology of frozen foods has reached a high level, but as in all methods of preservation the improvement process goes on.

FRUITS AND VEGETABLES—this session will be presided over by Dr. Amihud Kramer of the Department of Horticulture, University of Maryland, at College Park, Maryland. Dr. Kramer, an Associate Editor of FOOD TECHNOLOGY, has contributed to many phases of fruit and vegetable technology.

Amihud Kramer to chairman session on fruits and vegetables at Pittsburgh '57 meeting.

The FOOD ENGINEERING SESSION will emphasize continuous processing. Leading the session will be Mr. C. R. Havighorst, Associate Editor, *Food Engineering*. Mr. Havighorst's address is 68 Post Street, San Francisco, California. He has been close to developments in the engineering phases of food technology for many years.

C. R. Havighorst—Food Engineering

K. G. Weckel—Dairy and Poultry Products

Dr. K. G. Weckel, Department of Dairy and Food Industry, University of Wisconsin, Madison 6, Wisconsin, will chairman the DAIRY AND POULTRY PRODUCTS SESSION. Dr. Weckel has been active in the professional societies and has had a prominent role in the progress of dairy technology. He is a member of the Food Protection Committee of the National Research Council's Food and Nutrition Board.

W. L. Mallman—Sanitation and Sanitizing Agents

A new session in 1957 will be SANITATION AND SANITIZING AGENTS. The leader is Professor W. L. Mallman of the Department of Bacteriology, Michigan State University, East Lansing, Michigan. The importance of sanitation in the growth and health of the gigantic food industry needs no elaboration.

OBJECTIVE QUALITY CONTROL MEASUREMENT is the title of a session to be led by Dr. W. A. Gould, The Ohio State University. Dr. Gould's address is the Department of Horticulture, Ohio Agricultural Experiment Station, Wooster, Ohio.

The STATISTICAL QUALITY CONTROL SESSION will be led by Mr. C. B. Way, Quality Control Manager for Green Giant, LeSueur, Minnesota.

A session on ENZYMES has been scheduled for the 1957 meeting with Dr. E. F. Jansen as leader. Dr. Jansen heads the Fruit Processing Section of the Western Utilization Research Branch, 800 Buchanan Street, Albany 10, California. These are the U. S. Department of Agriculture laboratories for the Western States of the U. S. A.

E. F. Jansen—Enzymes

A session on Waste Disposal, with C. F. Woodward as chairman, has been scheduled. Dr. Woodward is head of the Fruit and Vegetable Section of the Eastern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture. The address of the Eastern Branch is 600 E. Mermaid Lane, Philadelphia, Pennsylvania.

C. F. Woodward—Waste Disposal Session

(Continued on page 18)

THE BEST WAY TO LOOK FOR PRODUCT IMPROVEMENT

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Our Research and Technical Service Representatives are available without obligation to assist you with any formulating or production problem. Please write or phone your requests.

ICE CREAM

Used by a majority of the country's manufacturers for over two decades, Frodex has numerous advantages for ice cream and ice cream specialties. Flavor is enhanced, texture is smoother, heat shock tolerance increased, total solids content is built up, meltdown is improved when Frodex is used in ice cream, stick novelties, sherbets, low fat and other specialties and novelties.

FROZEN FRUIT

The use of Frodex in freezing fruits and berries results in higher quality at considerable savings. Frodex prevents oxidation and dessication. It retains the natural color and more juice for full, firm fruit with greater natural fruit flavor. Frodex permits quicker freezing, and produces a higher drained weight.

MEAT PRODUCTS

Frankfurters
Sausages
Canned Meats

Frodex minimizes loss of color during processing and storage. It is an excellent moisture conditioner for longer shelf life, promotes better texture, less shrinkage and minimum watering-off. Frodex is a better binding agent for better appearance, stabilizes high fat-content products as an emulsifying agent.

DRY FOOD MIXES

In soups, icings, cake and pie mixes, dessert mixes, drinks, muffins, pancake mixes and similar dry food products, Frodex offers a number of distinct advantages both in production of the mix and in the finished product.

CATSUP

Frodex enhances natural color, retards oxidation, particularly in the neck of the bottle, and does not mask the true condiment flavors of the catsup.

CAKES and PIE CRUSTS

Cakes have increased volume, finer grain, smoother texture, prolonged shelf life, better flavor, richer crust color and are produced with a greater yield and at lower cost with FRODEX.

In pie crusts, FRODEX means better color, faster baking, improved flake, greater stability and crispness and enhanced flavor.

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(Continued from page 16)

B. L. Oser—Chemicals in Foods

Dr. B. L. Oser, Food Research Laboratories, 49-14 Thirty-third Street, Long Island City, N. Y. is the chairman of the session on CHEMICALS IN FOOD. Dr. Oser, who is Director of the Food Laboratories, has been engaged for many years in the direction of research in this important field, has furnished expert testimony before FDA and other regulative groups, and has been an active member of a number of national committees, among them the Food Protection Committee of the Food and Nutrition Board.

In addition, there will be a SYMPOSIUM ON TASTE TESTING AND CONSUMER PREFERENCE, organized by E. E. Lockhart. This will be an all-day session and will be scheduled for Thursday, the day following the regular technical sessions. Dr. Lockhart is Scientific Director of the Coffee Brewing Institute, 551 Fifth Avenue, New York 17, N. Y.

Ernest E. Lockhart—Symposium on Taste Testing and Consumer Preference

A session on INDUSTRY AND EDUCATION has been scheduled for the 1957 meeting in Pittsburgh. A direct result of the great interest shown in this topic at the Sixteenth Annual Meeting, this session will be led by Dr. Walter A. Maclinn, Chairman, Department of Food Technology, Rutgers University, New Brunswick, N. J.

First Call for 1957 Annual Meeting Papers. Titles of papers must be in the hands of the Program Committee not later than November 15, 1956, and the deadline for submission of abstracts shall be December 15. The Pittsburgh Meeting being in May makes these early deadlines necessary in order to allow sufficient time for final program formulation and publication.

Where to submit titles and abstracts. Authors are requested to submit titles and abstracts directly to the appropriate session chairman. Should there be a question as to the session in which a paper is likely to be placed, the author is requested to send title and abstract to one of the Co-chairmen of the Program Committee, R. E. Buck or C. R. Stumbo, Food Research Dept., H. J. Heinz Co., Pittsburgh 30, Pennsylvania. Upon receipt of the titles, abstract forms will be sent to authors for full details regarding the paper presentation and abstract.

Due to time and space limitations the technical program must be limited to approximately 120 technical papers. Thus, it is suggested that authors submit titles and abstracts as early as possible. December 15, 1956, is necessarily the final deadline. Date of receipt of title and abstract and appropriateness of material proposed for presentation will be the determining factors in case more papers are received than can be accommodated.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

September 5-7	International Ass'n of Milk and Food Sanitarians, Olympia Hotel, Seattle
September 10-17	The Perkin Centennial, Sponsored by the American Assoc. of Textile Chemists and Colorists, Commemorating the Discovery of Aniline Dyes, Waldorf-Astoria, New York
September 16-21	One hundred and thirtieth National Meeting of the American Chemical Society, Atlantic City, New Jersey
September 24-30	Third International Congress on Canned Foods, Rome—Parma
October 9-12	American Dietetic Association, Milwaukee
October 17-19	Nat'l Pickle Packers Association, Edgewater Beach Hotel, Chicago
November 12-15	American Bottlers of Carbonated Beverages, Public Auditorium, Cleveland
November 27-30	National Chemical Exposition, Public Auditorium, Cleveland
May 12-16, '57	**Institute of Food Technologists, Seventeenth Annual Meeting, Pittsburgh, Pa.**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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SELECTED ABSTRACTS . . .

Compiled by H. A. Campbell

ANALYTICAL METHODS

Further results on moisture determination of food by hydrogen nuclei magnetic resonance.

Elsken, R. H., and Kunsman, C. H. (Western Util. Res. Branch (USDA), Albany 10, Calif.). *J. Assoc. Offic. Agr. Chemists, 39* (2), 434-44 (1956).

The nuclear magnetic resonance (NMR) methods are satisfactory for all moisture detns. where there are no appreciable sol. solids, as is the case for many vegetable tissues. For materials contg. sol. solids, the H nuclei of the solutes absorb energy in the NMR spectrometer used in this investigation in a manner indistinguishable from those of H_2O. In the case where the sol. solids are const. and preferably small, a calibration curve may be made which relates moisture content with nuclear magnetic resonance absorption. A limiting factor to precise measurements in the high moisture range is the non-uniform character of many biol. materials in their natural state.

The Kluyver fermentation test for detecting preservatives in foods.

Mossel, D. A. A. (Central Inst. for Nutr. Res. T. N. O., Council for Applied Scientific Res. in Netherlands, Utrecht). *Food Manuf., 31* (5), 190-7 (1956).

Chemical methods for detecting preservatives in foods are usually tedious and time consuming. By comparison the Kluyver fermentation test is rapid and simple. Although nonspecific, it is still a most useful test, applicable to many foods such as jam, beer, lemonade, milk, ice cream and margarine.

Nitrogenous constituents in plants. I. Free amino acids in leaves and leguminous seeds.

Radhakrishnan, A. N., Vaidyanathan, C. S., and Giri, K. V. *J. Indian Inst. Sci., 37A*, 178-94 (1955); *Food Sci. Abstr., 28* (2), No. 751 (1956).

The free amino acids in exts. of the leaves of various plants were identified chromatographically. In most cases, the leaves were comparatively rich in asparagine, aspartic and glutamic acids, glycine, and alanine; they were deficient in some of the essential amino acids. Leaves of citrus plants contained large amts. of free proline. Similar detns. were made on exts. of Indian pulses, especially on seeds of *Phaseolus radiatus*, in which the amts. of free amino acids present were found to increase manifold during germination. Several unknown compds. reacting with ninhydrin, including some peptides, were detected in both leaves and pulses.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Salivary amylase in the rat.

McGeachin, R. L., and Gleason, J. R. (Dept. of Biochem., Univ. of Louisville Sch. of Med., Louisville, Kentucky). *Science, 123*, 841-2 (1956).

Rat salivary amylase levels are several times those found in human saliva. The enzyme is apparently an α-amylase.

The action of proteolytic enzymes on protein feeds. II. Intermediary products precipitated by trichloroacetic acid and phosphotungstic acid from peptic and pancreatic digests.

Birk, Y., and Bondi, A. *J. Sci. Food Agr., 6*, 549-56 (1956).

Peptic and pancreatic digests of fish meal, meat meal, soya bean and groundnut oil-cakes, and soya bean and groundnut proteins, were pptd. with trichloroacetic acid. The plant products, but not the animal products, yielded a protein fraction with 20 to 30 amino acid residues per mol., which was sol. in phosphate buffer at pH 8.3, and resistant to proteolytic enzymes, especially to pancreatin. A similar fraction was found in wheat gluten, maize protein, and sesame oil meal. The existence of this resistant fraction may be one of the reasons why plant proteins have a lower nutritive value than animal proteins. The trichloroacetic acid ppt. could perhaps be used as the basis for analytical differentiation of proteins of plant and animal origin. Precipitation of digests by phosphotungstic acid yielded the same fraction of high mol. wt. as pptn. by trichloroacetic acid, plus lower peptides and amino acids.

The mechanism of protein denaturation. VI. The denaturation of spherical proteins without changes in viscosity or optical rotation.

Tsiperovich, A. S., and Loseva, A. L. (Inst. Biochem., Acad. Sci. Ukr. S.S.R., Kiev). *Ukrain. Biokhim. Zhur., 27*, 494-501 (Russian summary, 501-2) (1955); *Chem. Abstr., 50*, 4257c (1956).

The denaturation of egg and serum albumin and of edestin under the influence of different denaturizing agents can take place without changes in viscosity. This applies particularly to the following 9 systems: egg albumin-Na salicylate, —formalin, $—MgCl_2$, $—H_2SO_4$, and —Na benzoate, serum albumin-formamide, —K thiocyanate, —acetamide and edestin-NaOH. The new macromol. structure which forms during denaturation can retain its close similarity to the original native protein, therefore, changes in protein viscosity and optical rotation should not necessarily be regarded as indicators of denaturation.

Metabolic pathway of linolenic acid.

Mead, J. F., Steinberg, G., Slaton, W. H., and Howton, D. R. (Atomic Energy Project, Univ. of California Med. Sch., Los Angeles). *Federation Proc., 15* (1), 313-14 (1956).

In expts. designed to shed light on the role of linolenic acid in essential fatty acid deficiency, carboxy-labeled methyl linolenate was administered to rats, and the lipids, fatty acids and polybromo fatty acids were prepd. from their organs. Linolenic acid was found to be readily converted to satd. acids and oleic but not to linoleic. The ether-insol. polybromide fraction was debrominated, hydrogenated and sepd. by chromatography into stearic, arachidic and behenic acids. Degradation of the arachidic acid in 4 one-carbon steps revealed that its precursor was formed largely from linolenate and acetate.

Biological effect of hydroxylysine.

Petersen, C. S., and Carroll, R. W. (Res. Labs., Quaker Oats Co., Chicago, Ill.). *Science, 123*, 546-7 (1956).

Data obtained from nutritional studies using microorganisms suggest that hydroxylysine has some effect other than, or in addn. to, that of serving as a nutrient that can, under conditions of suboptimal lysine supply, be converted into lysine or be exchanged for lysine in protein synthesis.

Biochemical role of vitamin E.

Nutr. Revs., 14 (1), 29-30 (1956).

Previous work with vitamin E and its relationship to the enzymes of terminal respiration is reviewed. References are cited which indicate that vitamin E is directly involved in biol. oxidation, rather than indirectly as previously supposed.

Metabolism of $NaHC^{11}O_3$: Effects of anesthesia and route of dosage.

Van Brugen, J. T. (Dept. of Biochem., Univ. of Oregon Med. Sch., Portland). *Proc. Soc. Exptl. Biol. Med., 91* (1), 140-3 (1956).

The time-course of respiratory $C^{11}O_2$ has been followed after intraperitoneal and intravenous dosage of $NaHC^{11}O_3$ into anesthetized and non-anesthetized rats. Nembutal has been shown to affect the turnover of injected bicarbonate through its depression of respiration. The anesthetic did not slow peritoneal absorption. The multiple bicarbonate dosage used did not lead to appreciable labeling in tissue lipids, and the contribution of $C^{11}O_2$ to secondary labeling reactions can under these conditions be ignored. Liver glycogen "fixed" a small but measurable amt. of the C^{11} label.

(Continued on page 22)

Got a Processing Problem?

Think your processing could be better? More economical? Ask the men at Quaker Oats—they can find the answer!

What Quaker has done in the food processing field is a truly *amazing* story. A story that *should* be told in person.

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Quaker's men and modern machines will work on *any* type of blended product. They insure you of highest quality. Quaker offers diversification of mills so all your eggs aren't in one basket. And Quaker is equipped to handle bulk—still another saving for you.

Quaker's resources and abilities in the processing field have only been touched upon here. The possibilities are endless. Let us help you as we have already helped so many major food companies. If you have *any* processing problem, call or write Industrial Food Sales, The Quaker Oats Company. No matter *what* the problem, it will be worth your while.

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(Continued from page 20)

World symposium on applied solar energy.

BENVENISTE, G., AND KASTENS, M. L. (Stanford Research Inst., Menlo Park, Calif.). *Science, 123,* 826-31 (1956).

It was estd. that the present estd. cost of growing *Chlorella* under the most favorable conditions is high. *Chlorella* protein cost approx. twice as much as proteins from other sources. *Chlorella* protein would cost about 57.3 cents per lb. in Japan and retail at about 76 cents per lb. These prices are higher than the cost of protein obtained from soybeans, mackerel, sardines or whale meat in Japan, but considerably less than the cost of proteins from eggs, milk, pork or beef. Rats fed *Chlorella* showed a lesser tendency to suffer from liver necrosis, and they did just as well with *Chlorella* proteins as they did with most usual protein diets.

MICROBIOLOGY

Nuclear division as observed in live bacteria by a new technique.

MASON, D. J., AND POWELSON, D. M. (Dept. of Biol. Sci., Purdue Univ., West Lafayette, Ind.). *J. Bacteriol., 71* (4), 474-9 (1956).

A method is described that uses high concns. of gelatin to increase the phase contrast within living bacteria. The sequence of division of cells of *Escherichia coli* and *Bacillus cereus* was photographed. The nuclear areas in these dividing cells appeared to be as clearly defined as the areas in fixed and hydrolyzed and stain cells. However, a pattern of nuclear division could not be formulated from the sequences studied.

Pink yeasts isolated from human skin surfaces.

HUXLEY, M. J., AND HURD, R. C. (Dept of Bacteriol., State Coll. of Washington, Pullman). *J. Bacteriol., 71* (4), 492-3 (1956).

A report on the identification of the pink carotenoid contg. yeasts that were isolated.

NUTRITION

The effect of penicillin on the thiamine requirement of the rat.

MAMEESH, M. S., SCHENDEL, H. E., NORTON, H. W., AND JOHNSON, B. C. (Div. of Animal Nutr., Univ. of Illinois, Urbana). *Brit. J. Nutrition, 10* (1), 23-27 (1956).

Some antibiotics are reported to have a sparing effect on certain B-vitamins. Penicillin improved the growth of rats given suboptimal levels of thiamine; however, it did not significantly alter the dietary requirement of thiamine for maximal growth. It is postulated that this is due to a condition which limits the ability of the deficient rats to efficiently utilize their dietary thiamine.

Copper metabolism in man.

GUBLER, C. J. (Salt Lake County Gen. Hosp., Salt Lake City). *J. Am. Med. Assoc., 161* (6), 530-4 (1956).

Cu is essential in mammalian nutrition; it is necessary for optimal absorption and metabolism of Fe, for normal erythropoiesis, for bone formation, and for a no. of oxidation-reduction reactions in tissues. Although Cu deficiency has never been clearly demonstrated in human subjects, nevertheless, Cu is undoubtedly essential for humans as well as for other animals and for plants.

Soya in the field of nutrition.

LEARMONTH, E. M. (British Soya Products Ltd., London, E. C. 3). *Chemistry and Industry, 18,* 360-7 (1956).

A review of existing knowledge about soya, covering the relationship between protein and oil yield and climatic conditions during growth, present day sources and end products, the carbohydrates of soya, soya as a source of fat, and finally the proteins of soya, their treatment to produce a more nutritive product.

Reduction of serum lipids by dietary management.

ROEN, P. B. (Hollywood Presbyterian Hosp., Los Angeles, Calif.). *Geriatrics, 11* (5), 200-02 (1956).

In 50 selected cases maintained on a low-lipid diet, serum total cholesterol was lowered an av. of 146 mg. per 100 cc. Irrespective of the height of initial readings, an av. of 82% of the max. drop was continued throughout the study. A substantial drop occurred even in patients with initial values of 210 to 265 mg. per 100 cc.

Diabetes—Overweight: U. S. problems.

HUNDLEY, J. M. (Lab. of Biochem. and Nutr., Natl. Inst. Health, Bethesda, Md.). *J. Am. Dietet. Assoc., 32* (5), 417-21 (1956).

Diabetes is discussed as a public health problem of peculiar importance in United States. Possible roles of diet and nutrition in the etiology of the disease were presented. The role of overweight and the importance of wt. control as an approach to diabetes prevention was emphasized.

What the homemaker knows about nutrition. IV. Her food problems, shopping habits, and sources of information.

YOUNG, C. M., WALDNER, B. G., AND BERRESFORD, K. (Sch. of Nutr., Cornell Univ., Ithaca, New York). *J. Am. Dietet. Assoc., 32* (5), 429-34 (1956).

Data are presented from a cross-sectional sampling composed of 645 homemakers in Rochester and Syracuse, New York. One third of the homemakers said they had problems which troubled them about planning, buying or prepg. food. The most common problem concerned meal planning; the next most common problem concerned problems relating to the cost of foods and motivating family members to eat various foods. The kinds of help most desired related to information on variety in food prepn., budgeting, quick menus, food habits and special diets.

PHYSIOLOGY AND MEDICINE

Experimental cholesterol atherosclerosis.

RANNIE, I. (Dept. of Pathol., King's Coll., Univ. of Durham and Royal Victoria Infirmary, Newcastle upon Tyne, England). *Proc. Nutrition Soc.* (Engl. and Scot.), *15* (1), 61-5 (1956).

The essential facts of exptl. cholesterol atherosclerosis have been established for almost half a century but their interpretation is still in dispute. Consideration of the findings points to the condition being an example of a thesaurosis or pathological storage of inert material. It is suggested that there is also illustrated the functioning of a mechanism by which foreign material is cleared from the blood stream by passing through the vessel walls from intima to adventitia. It is emphasized that thrombosis is not produced in the exptl. animals in this condition and that as thrombosis is the all important factor in the human lesion we cannot expect any help from the expts. in regard to elucidating the cause of coronary thrombosis.

The relationship of lipaemia to thrombosis and atheroma.

FULLERTON, H. W. (Dept. of Med., Univ. of Aberdeen, Scotland). *Proc. Nutrition* (Engl. and Scot.), 15 (1), 66-71 (1956).

The evidence for an assocn. between dietary fat and the incidence of coronary atherosclerosis is reviewed. Alimentary lipaemia accelerates the coagulation of blood *in vitro,* and may initiate the process of atherosclerosis by producing fibrin formation *in vivo.* The role of other factors, which may be important in the pathogenesis of atherosclerosis, is considered briefly.

Heart disease and soybeans.

CHEN, P. S. (Atlantic Union Coll. South Lancaster, Mass.). *Soybean Digest, 16* (8), 22-4 (1956).

A review of recent medical findings relative to cholesterol as a principal cause of coronary heart disease, arteriosclerosis and gallstones. The author recommends greater use of soybeans in the diet as a preventive measure, specifically meat substitutes, margarine, mellorine and soy milk powder.

Coffee plant chemical revives stored blood.

PRANKERD, T. A. (Univ. Coll. Hosp. Med. Sch., London). *Lancet,* April 21, 1956; *Science News Letter, 69* (20), 313 (1956).

Blood ready for discarding by blood banks after 3 wks. of storage can be held another 4 wks. and "revived" for transfusion by treatment with guanosine, a chem. from the leaves, and unripe berries of the coffee plant. Guanosine belongs to the class of chems. called nucleosides. When it is added to old blood and the mixt. incubated for an hr. at body temp., it revives the blood apparently by giving the red blood cells a chem. which can be used in the handling of glucose, or sugar.

(Continued on page 26)

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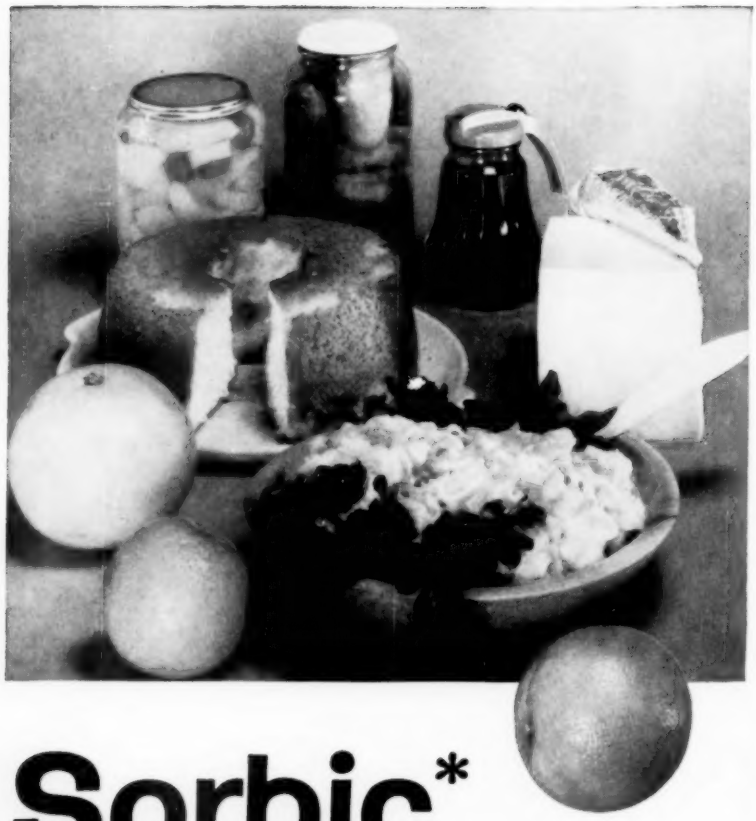

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(Continued from page 22)

ENGINEERING AND PLANT EQUIPMENT

Performance of an internally baffled multistage extraction column.

SCHEIBEL, E. G. (Hoffman La Roche, Inc., Nutley, N. J.). *A.I.Ch.E. Journal, 2* (1), 74-8 (1956).

A new type of baffling arrangement is presented for an internally agitated extn. column which provides uniform mixing of the phases in a smaller height than previously possible allowing the design of larger-diam. columns without requiring a proportional increase in height.

Spray drying of flavors.

METCALFE, L. S. *Am. Perfumer and Aromatics, 67* (4), 64+ (1956).

A brief discussion covering the essential features of flavor spray drying.

Design of heat exchanger heads for low holdup.

CICHELLI, M. T., AND BOUCHER, D. F. (E. I. duPont de Nemours & Co., Inc., Wilmington, Del.). *Chem. Eng. Progress, 52* (5), 213-8 (1956).

A novel head design for shell-and-tube heat exchangers is presented. The design incorporates features of low holdup, low pressure drop, and good flow distribution among the tubes. A comparison is made with alternate head designs. Information is also presented on the detn. of the head pressure drop and the reduction in heat-exchanger effectiveness due to flow unbalance.

About evaporation rates of water drops.

RADUSCH, R. (Forschungsstelle fur Feuerloschtechnik, Technischen Hochschule Karlsruhe). *Chem. Ing.-Tech., 28* (4), 275-7 (1956).

The influence of H_2O drop sizes upon evapn. rates and heat transfer coeff. of free falling drops is discussed. It is shown that a drop of 0.35 mm. has a min. heat transfer coeff.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

Some problems facing rice.

SMITH, G. T. *Rice J., 59* (4), 10-12 (1956).

In Texas and Louisiana, the government is expected to take over about one-half of the 1955 rice crop and is still holding rice from 1954 crop. Rice av. was cut 37% in past 2 yrs. and further reductions due in 1957. Rice industry strongly favors a two price support plan, not less than 90% of parity on rice for domestic market and Cuba and 50% on other rice. About 45% of 1955 Texas rice was Century Patna, two-thirds went to commodity credit corp. Century Patna was reported shunned by leading domestic marketers and branded inferior by Japanese buyers.

South Carolina passes enrichment law.

ANON. *Rice J., 59* (4), 16-18 (1956).

Effective July 1, 1956, it shall be unlawful in South Carolina, to sell any rice

(Continued on page 28)

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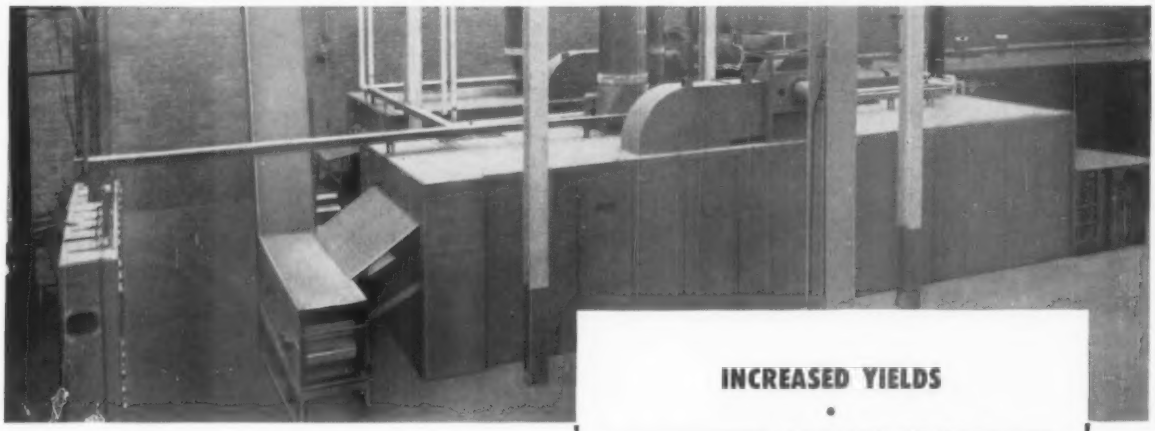

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Candy & Chocolate Coatings—reduces viscosity, increases coating capacity, less stickiness, retains moisture, lowers surface tension, improves texture and appearance.
Printing Inks—reduces grinding time, promotes better wetting and dispersion of pigments.
Shaving Creams—increases wetting power of lather, makes beard softer, gives smoother more "painless" shave.
Skin Lotions, Cosmetics, Beauty Soaps—softens and soothes skin, reduces irritation, increases cleansing power, stabilizes and improves lather.
Gravies-Sauces—prevents fat separation.
Peanut Butter—antioxidant—stabilizes flavor.

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(Continued from page 26)

which (effectively) has not been enriched with vitamins and minerals. This includes precooked rice products. Each pound must contain at least 2.0 mg. vitamin B_1, 16 mg. niacin, 13 mg. Fe plus other optional materials. Rice Journal editors predict that S. C. action will be followed in other states.

COCOA AND COCOA PRODUCTS

Sonics already boost chocolate output quality.

Mosimann, G. *Food Eng., 27* (5), 82 (1955); *Food Sci. Abstr., 28* (2), No. 872 (1956).

The application of ultrasonics in the chocolate industry is described. Pretreatment of the raw materials with ultrasonic waves reduces the conching time and improves the quality of certain types of chocolate, particularly with regard to flavor. Off-flavor in some types of cacao butter have been eliminated by means of ultrasonic treatment.

COFFEE AND TEA

Copper: its occurrence and role in tea leaf.

Child, R. *Trop. Agr., 32,* 100-06 (1955); *Food Sci. Abstr., 28* (2), No. 884 (1956).

In view of the use of Cu fungicides on tea plants, the British Ministry of Food in 1951 fixed a provisional limit of 150 p.p.m. of Cu in tea. Only a fraction of the Cu in tea is sol., and the content of Cu in brewed tea would not normally exceed the 2 p.p.m. allowed for other beverages. No disease due to Cu deficiency has been identified in tea, but Cu sprays appear to have a tonic effect on the plant apart from controlling fungal infection. Cu is an essential element in the fermentation of tea leaf, the polyphenolyoxidase involved being a Cu protein. Unsatisfactory fermentations seem to be assocd. with Cu contents below a certain level, reported as 12 p.p.m. by East African workers, and as rather more by workers in Ceylon.

FATS AND OILS

The meaning of commonly quoted analytical values of shortenings as related to shortening performance.

Stingley, D. V., and Wheeler, F. G. (Res. Div., Armour and Co., Chicago). *Cereal Sci. Today, 1* (1), 39-42 (1956).

Discussion of free fatty acids, color, I value, Wiley m.p., stability and flavor, active O_2 method, performance testing, wet creaming and icing vol. tests, layer cake test, H_2O absorption, dry creaming and prepd. mix tests.

Antioxidants based on soya.

Schade, H. *Fette u. Seifen, 56,* 1011-12 (1954); *Z. Lebensm. Untersuch. u. Forsch., 103,* 407 (1956).

A soya product was prepd. which retained its antioxidant properties and at the same time was debittered and had a high protein value.

FEEDSTUFFS

The use of chicken feather meal in feeds.

Wilder, O. H. M., Ostby, P. C., and Gregory, B. R. *Poultry Sci., 34,* 518-24 (1955); *Food Sci. Abstr., 28* (2), No. 817 (1956).

Meals produced commercially from feathers, by pressure-cooking and drying them, had an av. crude protein content of 87%. The protein has been shown to be deficient in lysine, tryptophan, methionine, and histidine. Feather meal fed to chicks to supply 12 to 30% of their protein gave excellent growth when accompanied by an equal amt. of protein from meat and bone scrap.

Moisture in feeds containing molasses.

Peckham, G. T. (Clinton Foods Inc., Clinton, Iowa). *J. Assoc. Offic. Agr. Chemists, 39* (2), 297-300 (1956).

None of the official moisture methods was found reliable for feedstuffs which contain both reducing sugars and sol. protein.

FRUITS AND VEGETABLES

Vitamin, mineral, and proximate composition of frozen fruits, juices, and vegetables.

Burger, M., Hein, L. W., Teply, L. J., Derse, P. H. and Krieger, C. H. (Wisconsin Alumni Res. Foundation, Madison 5, Wis.) *J. Agr. Food Chem., 4* (5), 418-25 (1956).

Eight vitamins, six minerals and proximate compn. were detd. on 14 frozen fruits, 7 frozen juices, and 30 frozen vegetables. Substantial amts. of ascorbic acid were found in all citrus juices, in practically all fruits, and in most vegetable products. Many of the products contained low levels of Na. This report markedly supplements the literature on the nutritional compn. of frozen foods.

GELATIN AND GUMS

Ion-exchange properties of agar.

Currie, T. (Brit. Deywood Co., Glasgow). *Chemistry and Industry, 116* (1955); *Z. Lebensm. Untersuch. u. Forsch., 103, 309* (1956).

Absorption of cations, parallels S-content of agars. Commercial prepns. contain varying amts. of ions, especially Ca^{++} and K^+. Exchange with H^+ cannot be accomplished without cleavage of sulfate groups.

MEAT AND FISH

Mechanics of bagoong (fish paste) and patis (fish sauce) processing.

Uyenco, V., Lawas, L. Briones, P. R., and Taruc, R. S. FAO of United Nations Indo-Pacific Fish. Coun., Proc. 4th Meeting, Quezon City, Rep. Philippines, 1952; Sect. II, pp. 210-22 (1953); *Food Sci. Abstr., 28* (2), No. 555 (1956).

Two of the most popular condiments used in the Philippines, bagoong (fish paste) and patis (fish sauce), are made from degradation products of fish protein in strong brine. The breakdown of the fish protein is mainly effected by the enzymes of the digestive organs, and not by microbiological activity, which generally increases the unwanted ammoniacal N in the product. The high salt concn. necessary for the degradation is not con-

(Continued on page 30)

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(Continued from page 28)

ducive to bacterial growth. Bagoong and patis are not formed by putrefaction and decay of fish protein. A new quick method has been developed for making patis; acid is used to hydrolyze the fish protein, thus eliminating bacterial activity. Any fish flesh may be treated by this method. This patis, although darker in color, is more appetizing because its odor is less strong. French literature on the prepn. of nuoc-mam, a product identical to patis but made in Indo-China, is reviewed, to elucidate chem. changes in the fish proteins during the processing of these products. Standardization of the quality of locally produced patis is recommended, using the N partition of Rose.

MILK AND MILK PRODUCTS

Role of ascorbic acid in development of oxidized flavors in dairy products.

Guthrie, E. S. Cornell Univ. Agr. Expt. Sta. Mem. 340 (1955); *Food Sci. Abstr., 28* (2), No. 613 (1956).

Oxidized flavors did not develop when ascorbic acid was completely oxidized during pasteurization. Pasteurization in the presence of 0.5 p.p.m. Cu resulted in development of intense oxidized flavors when milk was stored for long periods. Addition of ascorbic acid after pasteurization affected flavor adversely.

POTATOES

Carbohydrate components of the potato tuber.

Le Tourneau, D. (Agr. Chem. Dept., Univ. of Idaho, Moscow, Idaho). *J. Agr. Food Chem., 4* (6), 543-5 (1956).

The free sugars of Russet Burbank potatoes are glucose, fructose, and sucrose. No other sugars were detected. Fractions isolated were starch, an arabangalactan, pectin, hemicellulose, and a cellulose fraction.

PRESERVATION AND STERILIZATION

p-Hydroxybenzoic acid esters as preservatives. II. Acute and chronic toxicity in dogs, rats, and mice.

Matthews, C., Davidson, J., Bauer, E., Morrison, J. L., and Richardson, A. P. (Dept. of Pharmacol., Emory Univ., Ga.). *J. Am. Pharm. Assoc., Sci. Ed., 45* (4), 260-7 (1956).

The results of a study of the acute and chronic toxicity of *p*-hydroxybenzoic acid and the Me, Et, Pr, and Bu esters in mice, rats, and dogs are presented. All of these compds. possess a low order of acute toxicity. The toxicity of the Na salts appears to be a function of the length of the alkyl substituent, with the Bu ester about three times as toxic as the Me ester. The main toxic effect is an acute myocardial depression accompanied by hypotension. In concns. below 5%, none of the esters produce any evidence of primary irritation when applied to the intact skin of man. From the results obtained, it may be concluded that the Me, Et, and Pr esters of *p*-hydroxybenzoic acid may be used safely as preservatives in effective concns. for foods and drugs.

Problems in the use of antibiotics for preserving meat and fish.

Ingram, M., and Barnes, E. M. (Low Temp. Sta. for Res. in Biochem. and Biophys., Univ. of Cambridge). *Food Sci. Abstr., 28* (2), 121-36 (1956).

Review of preservation methods and implications toward public health.

INDUSTRIAL HEALTH

A cascade impactor with moving slides.

May, K. R. (Porton, Wiltshire, England). *Arch. Ind. Health, 13* (5), 481-8 (1956).

A cascade impactor is described in which the four sampling slides are mechanically traversed across the air jets simultaneously. This enables difficulties arising from overloading of the slides with particles to be overcome so that size grading of solid particles is more reliable. The system also enables changes in concn. and size distribution of aerosols with time to be observed. Alternatively up to 6 sep. samples can be obtained on the same set of slides by remote control.

Treatment of lead poisoning by edathamil calcium-disodium.

Shiels, D. O., Thomas, D. L. G., and Kearley, E. (Melbourne, Victoria, Australia). *Arch. Ind. Health, 13* (5), 489-98 (1956).

Edathamil calcium-disodium (dicalcium-disodium ethylenediamine-tetraacetate) taken orally in doses of 2 g. twice a day for adults caused from five-fold to thirty-five-fold increases in urinary Pb concn. and from five-fold to twenty-two-fold increases in urinary Pb excretion. In some instances this occurred on the first day of treatment. No serious untoward symptoms occurred during the course of treatment in our own cases. The clinical results were very favorable, amelioration of symptoms being noted early in the treatment.

PACKAGING

Heat-processible food films.

Nelson, A. I., Hu, K. H., and Steinberg, M. P. (Dept. of Food Technol., Univ. of Illinois, Urbana, Ill.). *Modern Packaging, 29* (10), 173-94 (1956).

An investigation of the performance of food-filled bags at cooking temps., with the use of a unique H_2O and air superimposing retort.

RADIOCHEMICAL TECHNOLOGY

The European atom pool.

Apeland, N. M. *Norg. Utenriksh. No. 8*, 232-5 (1956).

Great Britain is now West Europe's leading nation when it comes to atomic power. A new 92000KW station will join the power net work this year (a model and diagram of the plant is shown). It is indicated that the world's currently known sources of energy are as follows: coal—4%, oil—0.16%, natural gas 0.03%, uranium 93%, thorium 3.6%. Reference is made to Western European political problems.

Foods, drugs, and radioisotopes.

Lehman, A. J. (Div. of Pharmacol., Food and Drug Admin., Dept. of Health, Education, and Welfare). *Assoc. Food & Drug Officials, U. S., 20* (2), 56-62 (1956).

The use of radioactive materials affecting foods and drugs; current status of radiation food sterilization; current status of radiation drug sterilization; and the problem of public acceptance of radiation in sterilization or pasteurization of foods are discussed.

PATENTS

Process for preparing a food product.

Can. 523,978, April 17, 1956.

A process of treating sliced potatoes, which comprises washing the slices in a soln. contg. approx. 98.525% H_2O, 1.225% of salt, .25% of Na citrate and a small amt. of citric acid to obtain a pH value from 3.0 to 6.00 for a period of between ten secs. and ten mins. at a temp. ranging between 150° F to boiling.

Inhibition of caking of soluble coffee and the inhibited product.

Lee, S. Assignor to Am. Home Products Corp. U. S. 2,746,866, May 22, 1956.

The method of inhibiting caking of powdered solid sol. coffee ext. on exposure to moist air which comprises mixing with the coffee ext. a minor amt. of finely divided Ca gluconate. The method of inhibiting caking of powdered solid sol. coffee ext. on exposure to moist air which comprises mixing with the coffee ext. a minor amt. of lactose and a minor amt. of finely divided Ca gluconate.

Method of producing a frozen meat product.

Condon, H. M. Assignor to Grand Duchess Steaks, Inc. U. S. 2,752,252, June 26, 1956.

A process of treating meat which comprises the steps of fast freezing a block of raw meat at a temp. range of 0° F. to —40° F. to be in substantially hard frozen state throughout, tempering the hard frozen block to a temp. between 0° F. and 25° F., slicing from the tempered block relatively thin flakes of meat, tempering the flakes to be within a temp. range of 25° F. to 32° F., compressing a multiplicity of the tempered flakes into a compact integrated mass in which the softened flakes are thereby substantially impalpable in the mass, and freezing the compacted mass to hardened state throughout.

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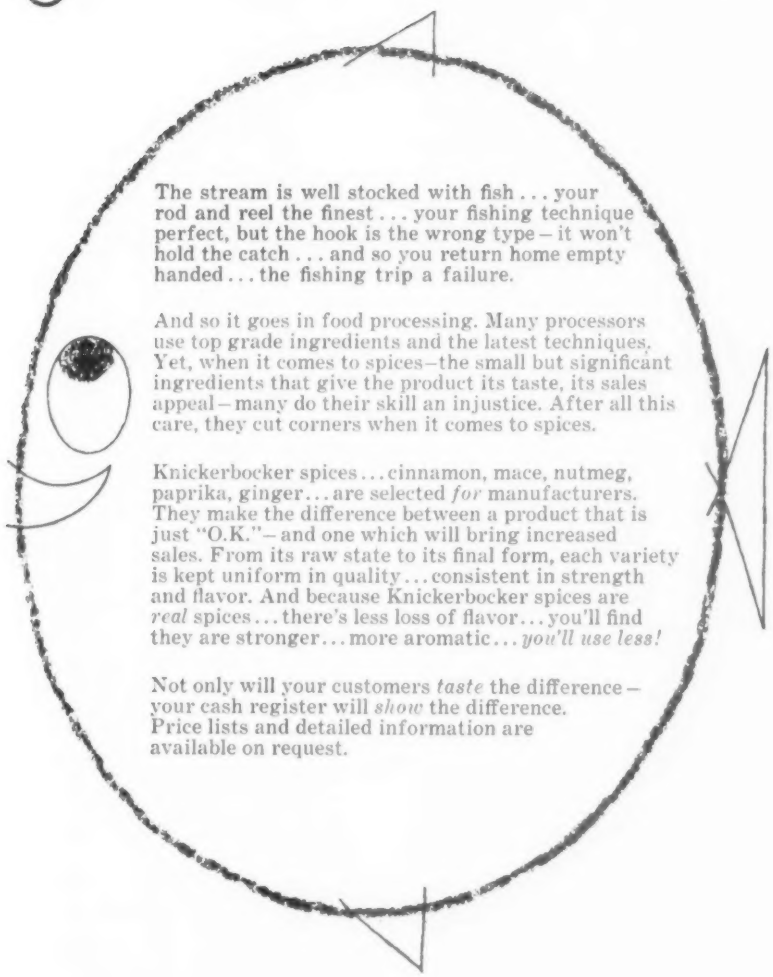

The stream is well stocked with fish . . . your rod and reel the finest . . . your fishing technique perfect, but the hook is the wrong type – it won't hold the catch . . . and so you return home empty handed . . . the fishing trip a failure.

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FOOD TECHNOLOGY AT THE UNIVERSITY OF ILLINOIS

REID T. MILNER
Head, Department of Food Technology
University of Illinois
Urbana, Illinois

THE DEPARTMENT OF FOOD TECHNOLOGY at the University of Illinois can trace its beginning to a faculty committee appointed by President Willard in December 1943. This committee (from the Colleges of Agriculture, Engineering and Liberal Arts and Sciences) surveyed activities of the University in the field of foods and suggested a relatively simple administrative structure to emphasize work on foods, report progress, and obtain support for food research. The College of Agriculture was urged to consider creating "a curriculum in Food Industries with several options as to the fields of specialization." In June 1945 the Alumni Association of the University appointed a committee on Food Technology headed by Dr. A. L. Elder, an alumnus active both in the Association and in the Institute of Food Technologists. At the same time a committee on Food Technology was created within the College of Agriculture. The Alumni committee surveyed 25 food companies to find their interests in food technology training. A Food Industry Conference was held in March 1946 at which about 30 representatives from industry discussed their views with an equal number of the faculty. Recommendations of the University Committee and the Alumni Committee were essentially the same. Both urged the establishment of a four-year curriculum, called "Food Manufactures" by the University group and "Food Technology" by the alumni. The need for emphasizing basic studies in the undergraduate curriculum and for a strong research program was stated by both groups.

First steps toward putting these recommendations into effect were taken in the fall of 1947. The program on Dairy Manufactures, formerly in the Department of Dairy Husbandry, was established as a division of the new Department of Food Technology. In September 1948 Dr. L. B. Howard became the head of the new department and started to select the staff and plan the courses. These tasks were essentially completed during the 1948-49 academic year. First courses in food technology were offered in the fall of 1949. Since the curriculum was started there have been a few changes in courses, but present requirements are essentially the same as those established when the department was organized. Seven years' experience has justified the original choice.

Dairy technology, a separate curriculum. In addition to food technology, a separate curriculum in dairy technology also leads to a B.S. degree. For many years it had followed conventional lines with specialized courses offered in the manufacture of butter, cheese, condensed and powdered milk, ice cream and market milk processing. This year, a drastic revision of the

A class samples its products, with S. L. Tuckey and P. H. Tracy standing by as observers.

dairy technology curriculum has been completed. New courses have regrouped the subject matter to place greater emphasis on principles, less on practice. Instead of five "product" courses, two processing courses are offered, one on perishable and the other on semi-perishable dairy products. The first includes, for example, pasteurization of milk and the second the use of fermentation processes in making cheese. Courses in control with respect to bacteriological, chemical, and general quality are designed to equip the student with some knowledge of most aspects of dairy products and their production. In Illinois small dairy creameries have been or are rapidly being replaced by large centralized companies. Therefore an effort is made to prepare the student for big business by requiring elementary courses in accounting and economics. As few courses as possible have been prescribed in the dairy curriculum. Of the 130 hours required for graduation 77 are specified and the remainder can be chosen from a wide group of electives. If the student plans to enter industry after graduation he can, with help from his advisor, elect enough courses in the College of Commerce to be trained in business management, selling, personnel or other such areas. If, however, he is preparing for teaching or research, the curriculum provides opportunity to take the languages, physics, additional chemistry and mathematics required. An additional advantage in the regrouping of the dairy courses is the opportunity offered to students outside the curriculum to gain a general knowledge of the field without taking a separate course in each product.

Food technology. The curriculum leading to a B.S. in food technology is planned somewhat differently. The assumption is made that training for work in the food industry at the B.S. level differs little from training for graduate work. This seems justified by comparison with the successful curriculum at Illinois leading to the B.S. in chemistry, which has been in force for many years. The graduate in food technology has had 38 hours of chemistry, the graduate in chemistry 40 hours. The emphasis on chemistry requires the student of Food Technology to take at least one chemistry course during each of 8 semesters and, on graduation, he has had biochemistry, physical chemistry and food analysis. Twenty-three hours of Food Technology are required. A one-year introductory course (6 hrs.) in

(Continued on page 34)

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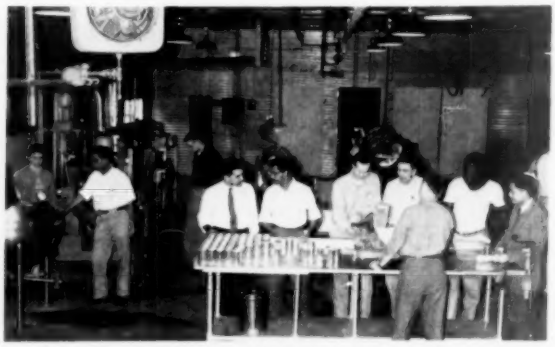
(Continued from page 32)

the junior year covers the principles of preservation (thermal processing, freezing, dehydrating) and diverse specific processing industries including cereals, sugars and sirups, meats, fish, oils and fats, beverages, etc. This is followed by a one-year course in food



A lab session in food processing.

processing for both advanced undergraduate and graduate students with major emphasis on laboratory work (8 hrs.). Using small scale equipment, students process a wide variety of food products, then store, sample, and evaluate them. Canning of acid and low acid fruits and vegetables, freezing these products, making jams and preserves, dehydrating, condiment manufacture, and citrus concentrates are covered in the first semester. The second half of the course includes the processing of meat, poultry, poultry products, formulated products such as soups, pork and beans, dry mixes, cereal processing, and freeze and vacuum drying of flesh foods. Films and plant trips are used to emphasize the practical aspects of the work and a three or four-day inspection trip to food plants is required of every senior student. Other required courses in Food Technology are on raw materials for processing (4 hrs.), principles of sanitation (2 hrs.) and introduction to process engineering (3 hrs.) taught by the Chemical Engineering Department.

In addition to emphasis on chemistry, food technology students are required to take 15 hours of mathematics (through calculus), 10 of physics, and 10 of bacteriology. These courses added to the general University requirements of rhetoric, military training, physical education and hygiene leave 18 hours of free electives for the student to choose. The basic knowledge required by a food technologist leaves no alternative to this schedule unless a fifth year is added to the program. Students are urged to work in food industry plants during the summers. The student gains not only experience but often impetus toward future work either in industry or in graduate study.

Since the establishment of Food Technology in 1948, 154 degrees have been awarded. Of these 58 were in Food Technology as follows: 63 B.S., 19 M.S., 25 Ph.D. Since some students received more than one degree, the total number trained is 53 men. Reports from these alumni have generally favored the curriculum as it now stands.

(Continued on page 40 following technical papers)

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PRODUCT TO BE FLAVORED	unit Batch of Product	OUNCES (AVOIRDUPOIS) OF VANIPROX SUGGESTED PER UNIT BATCH					
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Chocolate Coatings	100 lbs.	-	-	4½ - 6	4½ - 6	1½ - 2 See*	1½ - 2 See*
Cocoa	100 lbs.	7 - 9	7 - 9	2 - 3	2 - 3	¾ - 1	¾ - 1
Ice Cream	100 lbs. Mix	8 - 12	8 - 12	3 - 4	3 - 4	1 - 1½	1 - 1½
Ice Cream Powder (4 oz. = 1 pt.)	100 lbs.	-	-	-	-	4 - 6	4 - 6
Chocolate Syrup	10 gals.	7 - 9	7 - 9	2 - 3	2 - 3	¾ - 1	¾ - 1
Cream Centers Caramels	100 lbs.	4 - 6	4 - 6	1½ - 2	1½ - 2	½ - ¾	½ - ¾
Pudding Powder	100 lbs.	-	-	6 - 8	6 - 8	2 - 3	2 - 3
Baked Goods	100 lbs.	6 - 9	6 - 9	2 - 3	2 - 3	¾ - 1¼	¾ - 1¼
Whipping Cream	100 lbs.	2 - 4	2 - 4	⅔ - 1⅓	⅔ - 1⅓	¼ - ½	¼ - ½
Oil Icings	100 lbs.	4 - 8	4 - 8	1½ - 3	1½ - 3	½ - 1	½ - 1

* It is suggested that one pound of #9 be mixed with 2 pounds of sugar, bitter chocolate, or cocoa butter, and this paste added to the coating on a basis of 4½ to 6 oz. to 100 pounds just prior to completion of grinding of chocolate mass.

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Food Horizons[1]

Bernard E. Proctor

Department of Food Technology, Massachusetts Institute of Technology, Cambridge 39, Mass.

PROBABLY FEW WOULD HAVE PREDICTED, when the Nicolas Appert Award was initiated in 1942 by the Chicago Section of the Institute of Food Technologists, that within a few years the attendance at the annual meetings would reach the thousands, with a correspondingly large international membership. Yet these milestones have been reached already, and various other records are being broken each year.

The title of my discussion today is "Food Horizons." In laying the foundation for such a subject it would seem logical to review the past. As our time is limited, perhaps the aspects of food to be discussed should likewise be kept to a minimum.

I hope to confine my expressed thoughts to three subjects as they relate to Food Technologists. These are:

Future Food Supplies
Future Food Processes
Future Food Products.

Nearly two centuries ago the phantom of world wide starvation was raised. This dire prediction of Malthus and his followers in 1798 has yet to occur. Despite the steady increase in birthrates and the extended length of human lives, I personally consider that it is less likely to occur now than ever before.

THE FUTURE FOR FOOD SUPPLY

My reasons for being optimistic about the future for food production are based primarily on the increased ability of mankind to unlock and utilize the secrets of nature. Man-made nitrogen compounds are now produced in thousands of tons by the fixation of atmospheric nitrogen to make inorganic "fertilizers" for plants.

Plants can now be grown with simple organic salts in water solutions thereby developing plant protein for human food. Much attention has been paid to the green algae and their productivity under such conditions.

Already, food-expensive beasts of burden have been replaced, almost entirely, by petroleum consuming man-made machines which save both animal power and man power. There has also been a tremendous saving in the nutrients used by animals for their own metabolism.

Some of the amino-acids and polypeptides—the building stones of the proteins—have been synthesized in the laboratory; others will follow.

Today, sugars and fats can be synthesized—even parts of their respective molecules can be interchanged to form other compounds for use as foods or food adjuncts.

The day is not far away when all these reactions of the laboratory will be available as industrial processes for the development of food components; in fact some amino acids are now manufactured commercially.

I also predict that these developments will not await emergency food needs but will appear as commonly accepted peace-time practices.

Much more has been learned about photosynthesis and the ability to use energy from the sun with which plants are endowed. It is possible that the obstacles in learning of and utilizing this power from the sun may be overcome by human beings before the rate of population increase becomes more rapid than the rate of increase of food production.

Perhaps the greatest possible obstacle to the proper feeding of world populations is the constant threat of military conflicts which have so frequently come to fruition—and which now appear so capable of repetition. Wars are considerate of no one, are wasteful and divert manpower from normal food production. However, it would seem that such conflicts also catalyze imaginative and more efficient uses of food and also the more efficient production of food crops per man hour.

Today, we are endeavoring to teach the underdeveloped countries how to accomplish higher efficiency in food production; this is being accomplished, with U. S. funds, by visits of scientists and food technologists all over the world.

It must be admitted that the production of the necessities of a people does not ensure that they will be well fed. This has been amply demonstrated in many areas where races have literally starved in the presence of "nutritional plenty," through ignorance, bad food practices and customs, misunderstanding or poor leadership.

The incidence of these distressing situations should be relieved in the future by the valiant efforts of F.A.O., UNICEF, W.H.O. and various foundations which have saved untold lives through their far-seeing plans and the wise use of surplus foods and funds from this country.

FUTURE FOOD PROCESSES

The conflict between food needs and food supplies will also be controlled to some extent by the use of new processing methods.

Certainly, Nicolas Appert, whom we honor today, would be both surprised and gratified to count the lives—perhaps millions of lives, which have been literally saved by the process of heat treatment for preservation, in which he played so great a part a century and a half ago. Much has been done by others in the ensuing time towards improving these methods; such efforts should never cease as improvements are always possible.

During this period the use of hermetically sealed containers for the heat-treatment preservation of foods, both in metal and glass, has risen to astronomical proportions. Estimates of the tonnage of foods so preserved also show similar trends. More recently perhaps the largest increases have been in beverages and foods for both man and domestic animals, although the trend towards increased use is almost universal.

[1] The Appert Award Address, presented before the Sixteenth Annual Meeting of the Institute of Food Technologists, June 13, 1956, St. Louis, Missouri.

The utilization of mechanical refrigeration for food preservation by freezing was a later development; it followed Appert's major efforts by at least half a century and did not attain real status until the present century. Since this time, however, with the advent of refrigerated space for frozen foods in kitchen refrigerators and in all commercial eating places, the manufacture and consumption of frozen foods has been almost phenomenal.

Yet the quantities of frozen foods, despite the many finished forms in which they appear in this country, comprise less than 5% of our total food production and consumption.

The third major food preservation method, dehydration, which antedates all others, has decreased in use and volume as the two methods cited previously have become more important. Except in time of military emergency this type of product appears to have somewhat limited use. There are, however, a few exceptions, the more notable of which are dehydrated potatoes and dehydrated non-fat skim milk. Processes for these raw materials have been notably improved in the past decade and their product acceptance has correspondingly increased. The same may be said for a number of prepared soups in dehydrated form.

My discussion up to this point has been largely concerned with the past. Several food processes of recent origin, concerned with the use of heat for sterilization, involve somewhat novel applications of either the type of heat treatment or its combination with packaging. The traditional method of heat treatment has been to heat materials already packed in a container either hermetically sealed or capable of being so sealed. Mechanical methods of increasing the rate of heat penetration into the container, by agitation, have indicated promise for specific products. Liquids or slurries of purées or chopped foods may be sterilized in heat exchange equipment and subsequently packed in sterile containers.

The sterilization of food in a special food preparation room in which high air temperatures may be maintained in order to provide the temperatures necessary to sterilize foods has also been proposed.

Each of these developments in food preservation has definite merits, but none has gained wide acceptance to date. The ultimate test is that of product acceptance and an evaluation of the economic factors concerned.

While these methods, usually involving the use of heat, have each been subjected to intensive practical tests in pilot plant installations, the thoughts of other workers in the research field have turned to alternative possible means of food sterilization that may involve neither heat, nor cold, nor dehydration.

I should like now to touch on the future as it may relate to some of the research work being carried out at present. These thoughts will deal with the possible application of investigations now almost completely in the research stage.

Over a dozen papers on food irradiation as a means of food preservation were presented at this IFT meeting. I shall be very surprised if the food industry does not make considerable application of radiations in the future. This does not mean that I believe that all foods are suitable for this type of preservation or that there are cogent reasons why any particular food should be treated by such processes exclusively. With the present state of knowledge in this field, however, one may expect that the way will be clear for some of the advantages of radiation to come to fruition. It must be reaffirmed, however,—as I and some others in this area of interest have continued to point out—that this will not be something that happens overnight or which will cause any sensational changes in the present means of food preservation.

Thirty years ago it was prophesied that food freezing would replace food canning, yet, in 1955 more metal containers and more glass jars for processed foods were manufactured than in any year since canning began. In this same period freezing processes in the food industry have increased greatly—but this increase has been without apparent effect on many canned products. In fact, during the past five years more metal food cans were used than in the 23 year period from 1910 to 1933 and the annual per capita consumption of canned foods has increased from 30 lbs. to 96 lbs. in the past 25 years.

It is thus quite apparent that new food processes may mean more processed foods of many kinds—often with the same food processers having a share in the production of canned, frozen, or other products.

It is perhaps timely to allude to another development in food processing research which has reached the intriguing stage—that of food treatment by antibiotic compounds. With the thrilling increase in the use of such materials for their life-saving and health-promoting characteristics by the medical profession, the use of similar materials for the control of microorganisms in foods seems a small step. That this may be accomplished has been demonstrated in a number of instances.

How desirable this may be and what limits should be set for the logical use of such materials in foods are yet to be determined. There are many persons with definite opinions on this subject, however.

Among the important opinions which determine the future use of all new food processes are those of regulatory authorities, such as the U. S. Food and Drug administration in this country. At present this group is actively interested in all the findings concerning both the use of radiation and the use of antibiotics. Their decisions will have much to do with such procedures in the future.

FOOD PRODUCTS AND THEIR FUTURE

It is obvious that there has been a tremendous change in the type and number of processed food products which have been made available to the American public since the last war. Few, if any staples have disappeared completely but many new and unheard of products have made their maiden bow. Some have become very popular and are well beyond the "fad" stage.

No more startling revolution has taken place since the beginning of history than the revolution of the American kitchen and its "Chief of Operations" the American homemaker. This revolution takes the lady of the house out of the kitchen except for a very small

period of time each day, if she so desires. Perhaps the best example of this is our rapidly expanding kitchen vocabulary which now includes such words as: Bendix, Disposal, Waring Blendor, Mixmaster, Radar Range, mechanical dish washers, thermostatic electric percolators, electric vacuum cleaners, photoelectric toasters, electric steam irons, electric corn poppers, aerosol insecticides, air conditioners, electric knife sharpeners, fluorescent lights, infrared rotisseries, etc.

The food super-markets now display very casually a wide range of frozen food concentrates, brown-and-serve biscuits and rolls, frozen pies of apple, meat, or chicken; precooked fish sticks, TV dinners, cake mixes, powdered coffee and tea and scores of others. All are designed to save work, effort, time and trouble on the part of the homemaker and her helpers. These new products save time before meals and we may look to the future for more of such novel combinations as those now enjoying overwhelming popularity and acceptance. Many kitchen operations, such as deep fat frying, are becoming less known by the newer generation of homemakers because products requiring this function may now be bought ready to eat, thereby requiring no activity in the kitchen other than warming.

It must be emphasized that all such products are in packages, many with new forms of packaging and new types of packaging material. They vary from the well-known rigid metal containers of tinned steel, glass aluminum or cellophane, to heat stable plastics and films of every color, thickness and functional property for special purposes.

The foods so packaged range from "chicken in the basket" to pancake mix in an aerosol spray can, so that no mixing is needed and the material may be squirted directly onto a hot grill to be cooked in seconds.

This revolution means more industrial food processes and less work in the kitchen. It likewise means more problems and more employment for food technologists. It indicates a tremendous increase in the necessity for and amount of scientific control in food processing and manufacture. It means more added value in foods as they reach the consumer. It should mean safer, more consistently good food products for the family and more business for the food industries. It also creates a need for more food technologists.

Also, for the food packaging industries it indicates that the present upward trend of production must be followed by even greater increases.

Another prediction I would hazard is the increase in the packaging of many such food products — once thought of as specialties but now common—in one-trip disposable containers which may be used for warming or even for serving and then thrown away without washing. Such containers may obviate the other time consuming operation of dish washing which few homemakers like and many abhor. Only recently I saw an account of paper suits used in the atomic energy industry for personnel to wear on one day and then discard. We do essentially this today for food dishes and cups when we go on picnics. We are beginning to purchase many of our foods for the home in similar types of packaging. It will certainly increase in the future.

Another near revolution in food technology is the dawning appreciation of the great consuming public in America that flavor is one of the greatest attributes of an acceptable food product. More attention to flavor in food products has been paid by the manufacturers in the last decade than ever before, as a result.

It is my suspicion, though this cannot be substantiated, that before the almost universal utilization in this country of ice refrigerators, and more recently, the introduction and wide use of mechanical refrigerators which maintain definite temperatures for food storage, a fair proportion of the fatty foods must have been what we now consider rancid, to some extent, before they reached the table or the kitchen.

If this surmise is accurate the flavor level of acceptance of many food products has been changed. In most cases one might assume that it has been raised, because rancid foods are not considered acceptable in most homes today.

Certainly the flavor of foods is considered more critically and many choices in food purchases are dependent on flavors to an extent which is not completely realized. Perhaps coffee in its several forms could be considered an excellent example. Not only are premiums willingly paid for desirable flavor and extra packaging to preserve flavor, but in some instances a product of inferior flavor today will not be purchased even if offered at a discount price.

This appreciation of the importance of flavor and the factors which relate to food acceptance had their origin many years ago, in fact Nicolas Appert was one of those concerned with flavor. The real impetus came during World War II when the concept of food acceptance became fully recognized by the armed forces. At that time it was crucial, because it was found that some persons lower their food intake if the meals served are lacking in acceptance and continued practice of this sort lowers both human and military efficiency.

Thus the significance of qualified taste panels became apparent. The techniques of taste panel and consumer acceptance tests were devised, tested by statistical methodology, revised, improved, then widened in scope and importance. They have now become useful tools but are still capable of improvement.

Hand in hand with these were the chemical investigations which dealt with the chemical entities, compounds and groups which give rise to odors, flavors, and the "bouquet" of some viands.

One of the early pioneers in the chemical investigation of flavor was Dean Samuel C. Prescott, our first IFT president, who conducted a long and intensive micro-chemical investigation of coffee and the precursers to coffee flavor in the early 1920's.

Recent impetus has been given to the fundamental investigation of flavor components by the extensive searches directed toward the flavor changes which may take place as the result of food radiation by gamma rays and cathode rays. In this field, as in many others, the chemist is finding it more necessary to rely for a part of his endeavors on the equipment of the physicist.

Thus the flavor chemist is now utilizing mass spectrophotometers, infrared and ultraviolet spectropho-

tometric equipment in conjunction with paper chromatography and vapor-phase chromatography to fathom some of the responsible chemical compounds in food flavor and to separate the entities in the chemical reactions which are the bases of food flavor changes.

That such advantages are being taken is of salutary benefit to the food technologists and a tribute to the other branches of science that have been helpful.

The training of food technologists, both present and future, should embrace a generous indoctrination of our students in physics, physical chemistry and engineering in order that such tools as are now available in these fields may be intelligently appraised and used by those in responsible positions in food research in the future.

Food flavors are probably distinct from the consideration of texture in food products although no one would deny that texture is intimately related to food acceptance. In this area of food research much attention is now focussed on means by which texture may be objectively measured. One promising means by which this may be accomplished with greater accuracy and distinction is through the application of the strain gage, a common instrumental tool in the engineering field, combined with a simulated chewing device. An instrument or research tool of this combination, denoted as Strain Gage Denture Tenderometer, with some of its unusual characteristics was described earlier this year in FOOD TECHNOLOGY by a group of workers in the Samuel Cate Prescott laboratories.

Certainly these efforts towards basic research are typical of many others which are now being carried out around the world, and are now destined to improve our fundamental knowledge of foods, their components and characteristics. The knowledge so obtained may then be used in the improved application of the techniques and developments to provide and produce more acceptable and efficient food products.

The topic I suggested was "Food Horizons." My reaction is that the food industries, the science of food technology, the practice of food engineering, all have brilliant futures on the horizon. The limits are only the ingenuity, the initiative and the industry of food technologists, to understand the needs and desires of their fellow men and to see that by their efforts all are properly supplied with the right type, form, flavor, texture and diversity of foods and food products. It also involves teaching others what food technologists can do.

Thus we may look forward to better fed, more satisfied, more efficient and I trust, more peaceful world populations, enjoying more complete health and longer life than ever before.

Although some of these predictions may be far removed and in advance of his thinking, such progress as we make in this direction will be emulating, in spirit at least, the very substantial success of our most outstanding and illustrious predecessor, Nicolas Appert, in whose honor and memory we gather today.

A Study of Commercial Juice Apples of the Pacific Northwest[a]

A. M. Neubert, G. H. Carter, and D. W. Ingalsbe
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(Manuscript received May 17, 1956)

WIDE DIFFERENCES CAN OCCUR in the quality of apple juice, depending on the harvest and handling practice to which the fruit has been subjected. Some of the factors responsible for these differences have been previously studied by this laboratory *(5, 6)*. The present report describes results of a study to determine the juice quality of apples actually available to processors in the Pacific Northwest during the 1954-1955 pressing season. The range of quality encountered, as determined by organoleptic tests, is correlated with season and composition of the fruit. Because bruised fruit is so prevalent in commercial juice apples, the effect of bruising on juice quality was also investigated.

MATERIALS AND METHODS

Selection of fruit. Samples of the principal apple varieties available from Hood River, Oregon, and the Wenatchee and Yakima districts of Washington were taken periodically throughout the pressing season from fruit being used in commercial juice manufacture. About one-third of the Delicious and Jonathans were obtained from each area. All of the Yellow Newtowns were from Hood River, while all of the Winesaps were from the Yakima and Wenatchee areas. Most of the samples consisted of two boxes, about 70 pounds, of a single variety taken at random from loads during delivery. A number of duplicate 2-box samples were taken of the Delicious and Yellow Newtown varieties during the early part of the season to permit a study of the effect of ripening on juice quality. Additional, smaller samples were also taken of the Delicious variety during the early part of the season for starch analysis.

Studies on the effect of bruising on juice quality were made during the 1951, 1952, and 1953 seasons in connection with previously reported studies. Carefully harvested and composited samples of Delicious, Jonathan, and Winesap varieties were divided into duplicate lots. The fruit from one lot was allowed to fall about 3 feet onto a smooth concrete floor to produce at least one bruise about 1 inch in diameter on each fruit. Bruised and unbruised duplicates were allowed to ripen 2, 4, or 6 weeks before analysis and processing into juice. The incidence of rot in the bruised fruit was low, probably because the skin was unbroken.

Juice preparation. Clarified, canned juices were prepared from each 2-box sample of commercial juice-grade fruit on the day after collection by a standard procedure described in a previous study *(5)*. Juices were also prepared from duplicate 2-box samples of some of the Delicious and Yellow Newtown samples after they had been allowed to ripen at laboratory temperatures.

Analytical methods. Procedures for sample selection and chemical analyses were the same as described in previous ar-

[a] Presented at the Sixteenth Annual Meeting of IFT, June 10-14, 1956, St. Louis, Missouri.

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ticles *(1,5)*. Starch in the fruit was determined, and soluble solids, total sugars, titratable acidity, and tannin in the juice. Optical density of the juice was determined at 440 mμ with a photoelectric colorimeter equipped with 20-mm. tubes.

Taste tests. The comparative taste quality of juices from bruised and unbruised fruit was determined by the triangle difference method as previously described *(5)*. The relative quality of juices from each variety of commercial juice apples was determined by scoring 4 samples selected at random from all of the samples of a variety, one of which was presented in duplicate. In an attempt to make all taste scores comparable within a variety, a standard juice of that variety was presented in each test. These standards were prepared from special lots of fruit and by blending with juices from the samples under study to give a better than average flavor for the variety. The standards were arbitrarily assigned a score of 7 and the panel was instructed to score the unknown samples higher or lower, according to the amount of apple flavor, on a 1-to-10 scale. There were no restrictions on the range of values assigned by the tasters but results of those who failed to score the duplicates reasonably close were discarded for that test as were all scores of those tasters who frequently failed in this respect. Nine to 14 judges qualified in each test.

RESULTS AND DISCUSSION

Composition and flavor. Starch in the fruit and total sugar, total acid, tannin, optical density and ratio of total sugar to total acid of juices prepared from commercial juice apples of all varieties, as obtained from the processor, are shown in relation to pressing date in Figures 1 to 5. The sugar content of

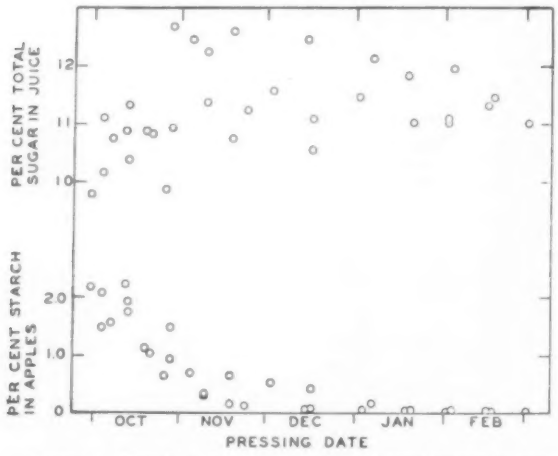

Figure 1. Starch in Delicious apples and total sugars in corresponding juices in relation to pressing season.

juices varied considerably within each variety throughout the season. This variation is not surprising when one considers the wide range of maturities, grades, sizes, and storage histories probably encountered and their effect on this constituent. Of particular interest, from the standpoint of juice quality, is the starch and sugar contents of the Delicious variety during the early part of the season. Of 12 samples taken in September and October, 9 contained less than 11% sugar which corresponded to less than 12.5% soluble solids. Only two of the 20 Delicious samples taken during the remainder of the season contained less than 11% sugar.

The low sugar and high starch contents of the Delicious variety show that adequate post-harvest ripening for good flavor did not have an opportunity to occur in commercial harvesting and handling of this variety during the early part of the season. Of 8 additional loads of Delicious sampled during October for starch analysis 6 contained more than 1% starch. Some post-harvest ripening apparently did occur in all varieties because none was as high in starch as was observed in unripened fruit in previous studies.

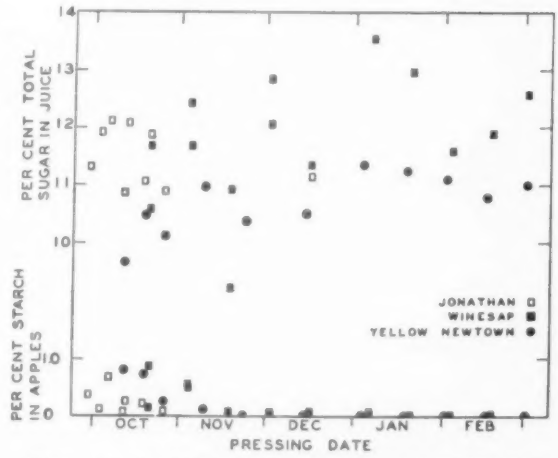

Figure 2. Starch in Jonathan, Winesap, and Yellow Newtown apples and total sugars in corresponding juices in relation to pressing season.

Even though the fruit was drawn from 3 different districts and was subjected to many unknown variables, optical density, sugar-acid ratio, and tannin content tended to increase and acid content to decrease in all varieties as the season progressed. The individual points in the figures show, however, that a relatively wide range of values may occur in these constituents and qualities throughout the season. The increases observed in sugar-acid ratio and optical density and the decrease in acid content are in agreement with results previously reported for the Delicious variety *(4)*.

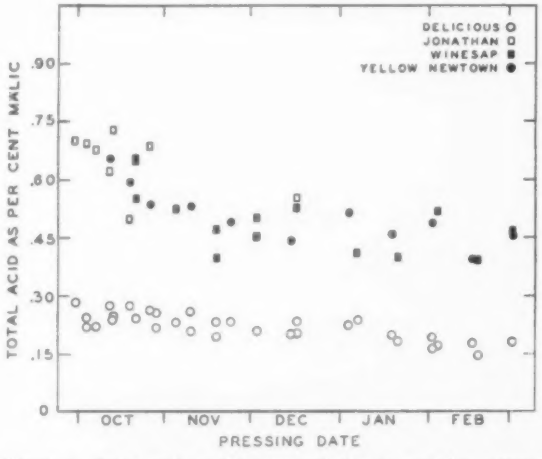

Figure 3. Total acid in juices in relation to pressing season.

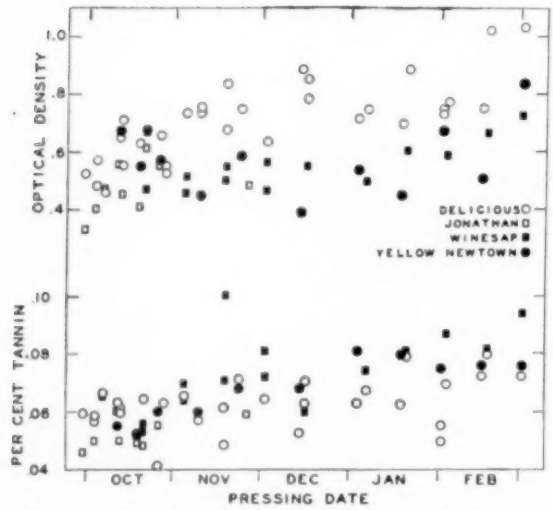

Figure 4. Tannin content and optical density at 440-mμ of juices in relation to pressing season.

The low soluble solids and high starch content characteristic of Delicious samples during October were accompanied by poor flavor, which was typical of the flavor associated with inadequate post-harvest ripening observed in a previous study. Poor flavors associated with overmaturity were not encountered in any of the varieties even during the latter part of the pressing season.

Flavor scores for juices are shown in relation to soluble solids content in Figure 6. Correlation coefficients (r) of +0.816, +0.873, +0.935, and +0.897 for Delicious, Jonathan, Winesap, and Yellow Newtown, respectively, were all highly significant ($p < .01$). A close examination of this figure shows that the Yellow Newtown points generally fall below and the Winesap points above the median. These displacements resulted because the taste panel standard juice for Yellow Newtown was somewhat lower in soluble solids than those for Delicious and Jonathan standards, while the standard for Winesap was somewhat higher. If all standards had had the same soluble solids content, the deviations for the median of all varieties would have been even less.

These data indicate that soluble solids, or sugar content, of the fruit would be a useful index in predicting juice quality for all varieties, regardless of source, when handled by commercial practices common in the area. The results are in agreement with the observation of a highly significant correlation between flavor score and Brix value of apple juices canned commercially in the United States in 1946 and 1947 *(2, 3)* and tend to justify the use of Brix as a quality factor in standards for grades of this product.

In comparing flavor scores with soluble solids, several factors not related to sugar content were recognized as influencing flavor scores. In one instance juice of relatively high soluble solids was scored down, probably because the fruit from which it was prepared had a high incidence of water core. In another the flavor score suffered because of a detectable off-flavor. A high soluble solids content therefore does not assure that the juice will have a desirable flavor.

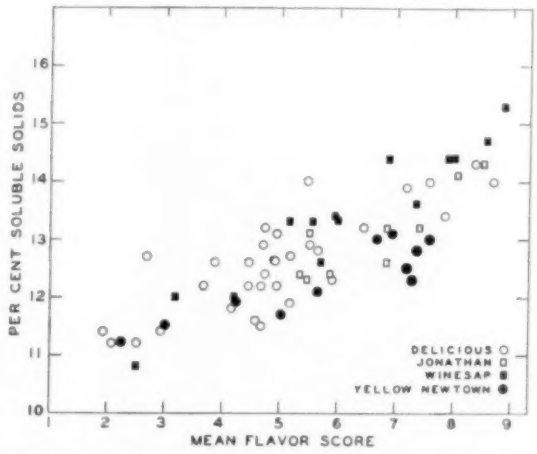

Figure 6. Relation of flavor score to soluble solids content of apple juice.

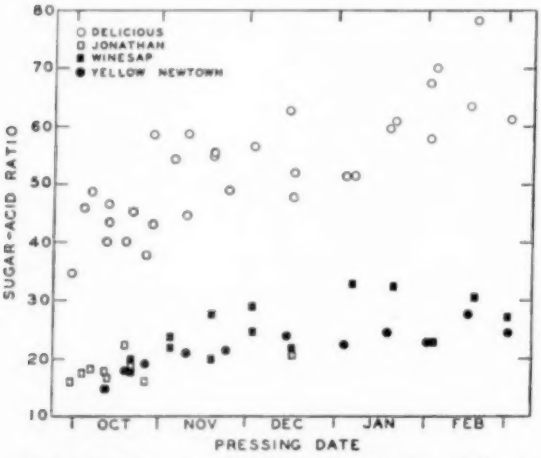

Figure 5. Ratio of percent total sugar to total acid in relation to pressing date.

Coefficients of correlation of flavor scores with sugar-acid ratios (+0.836, +0.724, +0.340, and −0.196 for Yellow Newtown, Winesap, Delicious, and Jonathan, respectively) were not as high as for flavor scores with soluble solids. The coefficients for Yellow Newtown and Winesap were highly significant ($p < .01$), while that for Delicious was significant ($p < .05$). Although the poorest-flavored juices were encountered in the early part of the season, there were wide differences in flavor throughout the season in all varieties. Low flavor scores were frequently associated with high starch content of the fruit, but starch was a poor index of juice flavor because many poor-flavored juices were obtained from fruit low in starch.

Bruising. Juices prepared from bruised and unbruised apples that had been ripened 2, 4, or 6 weeks

TABLE 1

Triangle difference taste tests of juices prepared from bruised and unbruised apples

Fruit used	Ripening period after bruising	Ratio correct judgments to total judgments[1]	Comments
	Weeks		
Delicious, "C" grade	2	11/13**	Acid off flavor in juice from bruised fruit
Delicious, "C" grade	4	14/28	.....
Delicious, "C" grade	6	23/27**	Juice from unbruised fruit considered sweeter
Jonathan, "C" grade	2	6/16	.....
Jonathan, "C" grade	2	7/13	.....
Jonathan, Fancy-Extra Fancy	2	12/18**	Juice from unbruised fruit considered sweeter
Winesap, Fancy-Extra Fancy	2	7/16	.....
Winesap, "C" grade	4	5/16	.....
Winesap, cull	4	0/16	.....
Winesap, cull	4	9/15	.....
Winesap, Fancy-Extra Fancy	4	5/16	.....
Winesap, "C" grade	6	8/18	.....

[1] The two asterisks are a standard symbol indicating significance at the 0.01 level.

after bruising showed no appreciable difference in total sugar, reducing sugar, acid, or tannin content. Bruised fruit retained appreciably more starch, however, and 12 bruised samples averaged 0.23% starch as compared with 0.14% for the unbruised duplicates. Qualitative iodine color tests showed much of this residual starch to be in and adjacent to the bruised area.

Results of triangle taste tests of these juices are shown in Table 1. In only three did the panel detect a significant difference in flavor. In two of these, juice from the unbruised sample was considered slightly sweeter, and an acid off-flavor served to identify bruised fruit in the third pair. These results indicate that moderate bruising need not appreciably affect the juice quality of apples, even when held for considerable periods after bruising.

Ripening. Bruising proved to be an important factor in ripening commercial juice-grade apples. Of 12 Delicious samples taken during October and early November, 6 were so severely bruised that 60 to 82% of the fruit rotted in 12 to 15 days' ripening at room temperatures. Flavor scores of juices prepared from the ripened, rot-free fruit of these samples was not increased appreciably, often because of the presence of off flavors. Of the remaining 6 Delicious samples with light to medium bruising, rot losses during ripening varied from 2 to 26%. Average flavor scores of juices prepared from the ripened, rot-free fruit were 0.3 to 5.0 points higher than those from similar but unripened samples. The improvement in flavor was roughly proportional to the amount of starch present in the unripened fruit. These results show the importance of care to avoid bruising if an attempt is to be made to up-grade the juice quality of fruit by post-harvest ripening.

Among 3 early-season samples of Yellow Newtown that were ripened 10 to 14 days, losses from rot varied from 9 to 23%. Average flavor scores were increased from 2.8 to 3.6 points by the ripening treatment. As has been previously discussed *(6)*, there would appear to be little purpose in post-harvest ripening of tart varieties in the Pacific Northwest where the Delicious variety predominates. Cold storage of tart varieties to conserve the higher acid content present during the early season would increase their usefulness for blending with low-acid Delicious.

SUMMARY

Commercial juice apples from three main producing areas of the Pacific Northwest were sampled periodically during the 1954-1955 pressing season to determine the range of quality available to processors. Soluble solids were found to be a good index of flavor of juices prepared from all varieties, regardless of season or area from which the fruit was drawn. Higher soluble solids were usually associated with better flavor. The soluble solids content varied considerably within each variety throughout the pressing season but low soluble solids and high starch were more characteristic of samples taken during the first month. The flavor of the juice was not appreciably affected by moderate bruising, even when the fruit was ripened 6 weeks after bruising. Post-harvest ripening of Delicious to improve flavor was found to be impractical after delivery to the processing plant because severe bruising in this grade of fruit resulted in heavy losses from decay.

Acknowledgments

The authors express their appreciation to volunteers of the Washington State Irrigation Experiment Station staff for their faithful participation in the taste panel.

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Effect of Unit Processes on the Salt and Moisture Content of Hams Processed Country Style[a]

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(Manuscript received June 21, 1955)

SPOILAGE OF CURED MEAT on the farm and in rural curing plants constitutes a waste of major proportions. Rodgers and Haynes *(5)* have estimated that the quantity of spoiled meat reaches a total of about 50 million pounds annually in the Southern States. A large part of this spoilage is known to be of bacterial origin and is thought to occur despite good curing practices. Because of the severity of the problem, many State and Government agencies have directed considerable research toward determining the cause and effecting remedies *(5)*. The process of dry-curing hams, the method most widely used on farms and in curing plants, has been described by Woodroof and Haynes *(6)*, Richmond *(4)*, and by U. S. Department of Agriculture workers *(1)*. The process consists of rubbing and depositing a given quantity of dry salt or mixtures of salt sugar, and nitrate on the surface of the meat in one or more applications. The meat is held under refrigeration at a temperature of 38° F. until the salt is thought to have penetrated sufficiently to render the meat safe for storage at higher temperatures. Recommendations are generally on the order of 2 days of cure per pound of ham and a minimum of 25 days.

The curing operation is considered essential to preservation. Other operations, such as soaking, drying, smoking, and aging, are frequently used, but are intended primarily for their effects on the color, aroma, and flavor of the meat and only to a limited extent for their preserving effects.

The possible influence of operations other than curing on the growth of the spoilage anaerobes of the genus *Clostridium* has been studied extensively by Mundt and Kitchen *(2)*. They have reported that certain anaerobes frequently incriminated in ham spoilage will not grow at 40° F., but when the temperature is raised to 89° F., the organisms will grow in basal medium having a salt concentration of 6-8%, and to a limited extent at a 4.0% concentration of salt in the presence of 0.05% KNO_2.

In a second study Mundt, Mayhew, and Stewart *(3)* found that spores of *Clostridium sporogenes* would germinate at temperatures of 39.9° F. and 98.6° F. in spleen infusion medium containing 8% NaCl. In most instances, germination was about 90%, and variations in pH from 5.3 to 8.0 had little effect. From their study, it was postulated that spores of Clostridia may germinate in meat in long cure and become metabolically active under conditions favorable to growth.

The probability of germination of spores of anaerobes in meat during cure points to the need for basic information on the salt and moisture contents of the meat at various steps in the curing process. The purpose of this study was to provide such information on hams given the so-called "dry" or "slow" or "cover" cure.

EXPERIMENTAL

The sixteen hams used in the tests were paired from 8 hogs of comparable weight and degree of finish. Dressed hogs were chilled to a temperature of about 34° F. overnight before being cut up. Hams were long cut, with skin untrimmed, and individually weighed. The dry cure was applied on the basis of 1¼ ounces per pound of ham, half of this amount being applied 7 days after the first application.

The dry-curing mixture used was the conventional 8-2-2 formulation (8 lbs. NaCl, 2 lbs. granular cane sugar, and 2 oz. $NaNO_3$). Hams were placed in wooden bins in a curing room maintained at 38° F. and cured for 40 days. At the end of this period they were removed and soaked for one hour in water having an initial temperature of 84° F.

Half of the hams were dried for 60 hours in a tunnel under forced convection with an average air velocity of 280 ft. per min. and an average temperature of 56.4° F. Remaining hams were dried for an equal time interval under natural convection at a temperature of 56° F. Relative humidity of the ambient air with both lots averaged 39.7%.

The hams were redivided for smoking. Half of the hams were given a long cool smoke at 85° F. for 70 hours, and half were given a warm smoke at 125° F. for 24 hours. Average internal temperature of the hams reached 84° F. and 112° F., respectively, at the conclusion of the smoking operation.

After smoking, hams were redivided into 3 lots and aged for 78 days under the following conditions: in an attic with temperature fluctuating, averaging about 76° F.; in a fairly tight wooden cabinet with temperature held thermostatically at 85° F.; and in a refrigerated space held thermostatically at 38° F. Only hams stored in the attic were wrapped for protection against insects. A summary of the various curing operations and routing of the hams is given in Table 1.

Sampling procedure. A sample was taken from each ham following each unit operation in the curing process for use in moisture and salt determinations. Samples were in the nature of plugs made on the butt end of the ham with reference to the aitch bone, from the cut side to the skin of the ham. The plugs were made with an improvised boring tool consisting of a section of stainless steel tubing sharpened to a cutting edge at one end. Cavities made by the boring tool were completely filled with loin fat to prevent unnatural drying of the cut section during subsequent operations.

Each cylindrical plug of meat was divided transversely into 3 sections of equal length to provide information on depth of salt penetration and longitudinally to provide duplicate samples for analysis.

All visible free fat was removed from the sections. However, the remaining intramuscular fat was left in the lean and carried through with it in subsequent analysis. Each sample thus prepared weighed about 4-5 g.

Analytical procedure. Samples of meat were weighed in porcelain crucibles on an analytical balance. Moisture was recorded as difference in weights before and after drying in an

[a] Presented at the Fifteenth Annual Meeting of IFT, Columbus, Ohio, July 1, 1955.

[b] The authors were with the Tennessee Valley Authority, Knoxville, Tenn., at the time this work was done. Other contributors were S. R. Cecil and J. G. Woodroof of the Georgia Agricultural Experiment Station and Benjamin L. Bussey of the Atomic Energy Commission, Savannah, Georgia.

oven at 102° C. for 16 hours. Porcelain crucibles were used throughout the analytical procedure instead of the more desirable platinum in view of the large number of samples handled.

All samples were ashed according to the procedure given in Section 12.41 of *Official and Tentative Methods of Analysis*, 6th ed., AOAC. Chloride was determined by the Volhard Method outlined in Section 12.43 and 12.44, except that dichlorofluorescein was used as the indicator instead of the usual ferric ammonium sulfate.

TABLE 1

Flow sheet showing routing of hams through curing processes

Curing	Soaking	Drying	Smoking	Aging[1] (78 da.)
		Forced Convection	Cool Smoke	Room Temp.
40 days at 38° F. 8.2-2 curing mixture[2]	1 hr. at 84° F.	60 hr. at 56.5° F. (avg.) Air vel.—280 ft./min. (avg.)	70 hr. at 85° F.	fluctuating—avg. about 76° F.
1a,[3] 1b[3]	1a, 1b	1a	3a, 3b	4a
2a, 2b	2a, 2b	2a	4a, 4b	5b
3a, 3b	3a, 3b	3a	5b	7b
4a, 4b	4a, 4b	4a	6b	8b
5a, 5b	5a, 5b	5a, 5b	7b	
6a, 6b	6a, 6b	7a, 7b	8b	
7a, 7b	7a, 7b			
8a, 8b	8a, 8b			
		Natural Convection	Warm Smoke	Cabinet
		60 hr. at 56° F. (avg.)	24 hr. at 125° F.	constant temp.—85° F.
		1b	1a, 1b	1a, 1b
		2b	2a, 2b	2a, 2b
		3b	5a	6a
		4b	6a	7a
		6a, 6b	7a	8a
		8a, 8b	8a	
				Refrigerator
				constant temp.—38° F.
				3a, 3b
				4b
				5a
				6b

[1] Hams were wrapped in Kraft paper.
[2] Applied at rate of 1¼ oz. per lb. of meat.
[3] The letters "a" and "b" denote pairs, i.e. 1a and 1b are paired hams from the same hog.

RESULTS AND DISCUSSION

Average concentrations of salt and moisture at various levels in the lean meat at the end of each unit process are tabulated in Table 2. Average values are shown graphically in Figures 1 and 2. As would be expected, salt concentration in the top section is substantially higher than in the lower section, since the salt was largely applied to the top surface of the ham.

The skin covering the bottom of the ham and the overlaying fatty layer were probably effective barriers to salt penetration, as shown by the low salt content of 0.15-0.86% in the bottom section of the hams after 40 days of curing. However, the relative effect is somewhat obscured by the nature of the salt application—with the larger proportion having been applied to the top or trimmed side of the ham.

Effect of the soaking operation was to lower the relative salt concentration in all 3 sections in the meat with little or no effect on the moisture contents.

Effect of the drying operations was to increase the salt concentrations in all 3 sections. Forced convection of air in the velocity range used had no effect on the salt and moisture content of the middle and bottom sections (Table 2). Moisture content was lowered slightly in the top section, but to no appreciable extent in other sections. Chief value of this operation from a preserva-

TABLE 2

Average percent salt and moisture at three levels in ham

Process	Section[1]	Percent Salt		Percent Moisture	
		Average	Range	Average	Range
Curing	Top	6.63	4.18-9.01	63.1	57.4-66.4
	Middle	1.26	0.61-2.81	69.6	67.2-71.4
	Bottom	0.406	0.15-0.86	71.3	68.8-72.4
Soaking	Top	4.32	3.43-7.19	63.9	58.2-69.2
	Middle	0.306	0.02-0.89	67.3	60.6-71.3
	Bottom	0.290	0.08-0.45	68.5	65.7-71.1
Drying					
Forced Conv.	Top	5.36	3.38-6.94	61.8	58.3-64.9
	Middle	1.70	0.73-2.86	68.9	62.7-71.4
	Bottom	0.805	0.39-1.55	69.9	65.0-71.9
Natural Conv.	Top	5.33	4.41-7.05	62.1	58.9-63.9
	Middle	1.70	0.52-2.61	69.0	66.0-71.6
	Bottom	0.64	0.21-1.10	70.2	68.1-72.3
Smoking					
Long, Cool	Top	6.46	5.43-7.12	58.8	54.7-61.6
	Middle	3.58	2.72-5.26	68.6	65.9-70.5
	Bottom	1.42	1.08-1.96	70.2	69.0-71.6
Short, Warm	Top	6.58	5.48-7.76	60.4	57.8-63.4
	Middle	3.68	2.66-4.92	70.4	68.8-73.8
	Bottom	1.48	0.82-2.24	70.9	69.8-72.8
Aging					
Room Temp. (avg. 76° F.)	Top	4.01	3.76-4.20	49.7	47.3-51.9
	Middle	4.26	3.68-4.91	57.6	56.2-58.8
	Bottom	4.44	3.99-5.34	60.3	54.8-62.6
Cabinet (const. temp. of 85° F.)	Top	4.29	3.56-5.29	50.01	43.0-56.1
	Middle	4.82	3.92-5.70	57.64	53.5-61.3
	Bottom	4.65	3.80-5.32	59.04	54.7-63.9
Refrigeration (const. temp. of 38° F.)	Top	4.24	3.83-4.49	53.7	50.4-58.1
	Middle	4.09	3.77-4.33	57.6	55.5-61.1
	Bottom	3.88	3.71-4.16	58.6	56.5-63.5

[1] Top section was in contact with salt, the bottom section was adjacent to skin, and the middle section was in between.

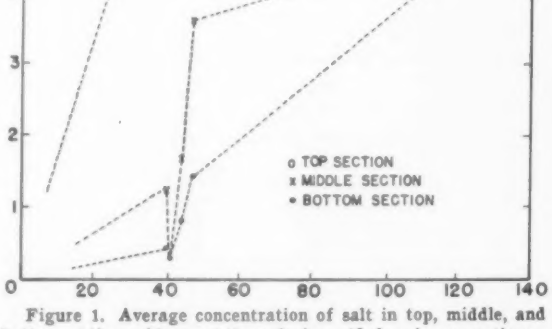

Figure 1. Average concentration of salt in top, middle, and bottom sections of hams at the end of specified curing operations.

tive standpoint probably would be its influence on salt migration to the interior of the ham prior to exposure of the ham to temperatures favorable to the growth of anaerobes. Hence, the term "tempering" rather than "drying" would more nearly describe the true function of this operation.

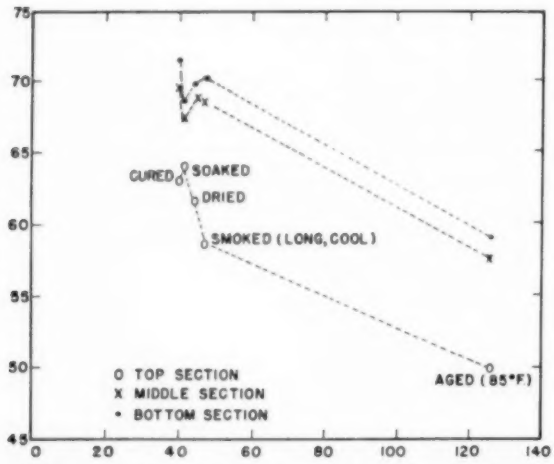

Figure 2. Average moisture content of top, middle, and bottom sections of ham at the end of specified curing operations.

Effect of the smoking operations was similar to that of the drying operations in that the salt concentration increased in all 3 sections of the hams. Moisture content was lower in the top or outer section, but practically unchanged in the middle and bottom sections.

The two types of smoking operations—the long, cool smoke and the short, warm smoke— had almost equivalent effects on salt concentration and on moisture content, except in the top or outside section in which the moisture was 3% lower in the cool-smoked hams. Overall average weight losses of the cool and warm-smoked hams were 2.18% and 1.87%, respectively.

The 78-day aging process resulted in almost complete salt equalization in hams aged at room temperature and in hams aged at constant temperatures of 85° F. and 38° F. Moisture was lower in all sections for each aging operation, and the effect of equalization was absent due to continuous drying of the hams.

A review of the selection of hams in retrospect indicates no advantage was gained in using paired hams. Randomized selection for routing would have been just as effective. This conclusion is drawn from an analysis of variance which indicates the variance between pairs to be as great as among "right" hams and among "left" hams.

SUMMARY AND CONCLUSIONS

A number of significant points were gained from this study which may have bearing on future concepts of the role of salt and of moisture in the curing process.

The concentration of salt remained low in the middle and bottom sections of the ham throughout the curing, soaking, and drying operations for an average of 1.70% and 0.64%, respectively, at the end of drying.

The soaking operation reduced the relative concentration of salt at all levels and as a result may have a negative influence on the preservative aspects of curing.

The drying operation appreciably increased the concentration of salt in the middle and bottom sections of the ham. Hence, it may be of maximum value when carried out at temperatures substantially lower than optimum temperatures for growth of Clostridia. There is very little to be gained from the use of forced convection over natural convection, since drying is slight and since time and temperature appear to be more important factors in influencing the rate of salt penetration.

The short, warm smoking operation and the long, cool smoking operation had equivalent effects in increasing the salt concentration in all three sections of the meat. Moisture was decreased only in the outside section.

Moisture changes in the three sections were slight throughout the soaking, drying, and smoking operations. Hence, it is probable that the chief contribution of these operations to the preservation of the hams is their effect on salt equalization.

Salt concentrations varied widely among hams in all operations through the smoking process. This large variance may be attributed to a number of factors such as distribution of salt on surface, differences in the ratio of lean to fat at the meat-salt interface, variations in the amount of inter- and intramuscular fat, and differences in thickness of the hams. The low concentration of salt in the inner sections of some hams may well contribute toward a disposition to spoilage.

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Effect of Fat-Soluble Antioxidants on the Stability of the Red Color of Peppers[a]

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(Manuscript received May 22, 1956)

CAYENNE AND PAPRIKA PEPPERS lose color on storage after processing. Speed of loss is influenced by conditions of storage, variety of pepper, and somewhat by conditions of harvesting *(4)*. Van Blaricom and Martin *(10)* found that addition of certain fat-soluble antioxidants and sesame seed reduced the loss of red color. Zechmeister and Cholnoky have shown that the chief pigments of paprika are carotenoids, in the form of esters of capsanthin, capsorubin, zeaxanthin, cryptoxanthin and other unidentified carotenoids, as well as some β-carotene *(3)*. Use of antioxidants to preserve the carotene of alfalfa by a spray process *(9)* suggested the application of such a process in stabilizing the carotenoids of peppers.

EXPERIMENTAL

Preliminary tests of the efficiency of the antioxidants were made on 20 g. samples of pepper. The antioxidant was dissolved in hexane or the least amount of acetone which would allow further solution in hexane. Five ml. of the antioxidant solution was added slowly to the dry ground pepper with thorough mixing and allowed to stand for 5 minutes to permit thorough penetration of the antioxidant. Excess hexane was removed under reduced pressure and the process repeated. As a control, equal amounts of hexane without antioxidant were applied in the same manner. No loss of color in either case was found.

With antioxidants which showed promise in protecting the pepper pigments, 500-g. samples were tumbled in a rotating metal cylinder equipped with baffles, 20 cm. in diameter and 25 cm. in length. During application of the antioxidant-hexane solution, the open end was covered with a cloth with a hole large enough to admit the nozzle of an atomizer powered by compressed air. This was an adaptation of the apparatus described by Thompson *(9)* for spraying alfalfa meal. Proportions of hexane solution to pepper were the same as for the 20-g. samples. Rate of spraying was adjusted so that the pepper was thoroughly covered but no portion became so wet that solution of the pigment occurred. In other trials, the antioxidant-hexane solution was added slowly to the dry ground pepper in a small batch mixer. Both processes gave results comparable to the small test samples in color retention of the subsequently stored pepper.

Samples were stored in stoppered two-ounce glass bottles at 37° C. in an incubator. Some samples were kept at 25° C. on open shelves out of direct sunlight. Aliquots were taken at 14- or 30-day intervals depending on color stability of the control sample. Color is expressed as percent retention of the original color *(4)*.

Color-stable and -unstable paprikas and cayennes of the 1952 to 1955 harvests inclusive, grown at Clemson by the Horticulture Department, were used for most of the tests. Also tested were: chile peppers grown in New Mexico; cayenne pepper, paprika, and chile pepper grown in California; imported Spanish paprika, and paprika grown in California packaged to be sold in this area. Peppers may lose color readily because of the time at which they are harvested *(4)* or this characteristic may be inherent in the strain or variety. Effect of antioxidants on both types of discoloration was determined.

Antioxidants tested were those which had been shown to be effective in preserving the carotene of alfalfa meal *(6,7,8,9)*, or were fat-soluble antioxidants commonly used for food products. Van Blaricom and Martin *(10)* have shown that water-soluble antioxidants were ineffective in preventing color loss in peppers. Each antioxidant was tested with a very color-unstable paprika and a cayenne pepper which was relatively color-stable. The cayenne, Carolina Hot, is used in commercial production in South Carolina.

RESULTS

Effect of the antioxidants on a color-unstable paprika and on a more color-stable cayenne is given in Table 1. Santoquin and DPPD were found to be the most effective. They are also very effective for the carotene of alfalfa meal *(6,7,9)*. Alpha-tocopherol and 2,6-ditert-butyl-4-methylphenol were very poor or ineffective. Protective effect of the antioxidant gradually disappeared over many months of storage. There was no sudden increase in color loss.

TABLE 1

Efficiency of antioxidants for the retention of the red color of pepper after storage at 37° C.

Antioxidant		Color retention			
		paprika		cayenne	
		6 weeks	22 weeks	6 weeks	22 weeks
	%	%	%	%	%
Control	0	22	0	63	21
6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline (Santoquin)	0.1	88	75	95	87
2,5-di-tert-butylhydroquinone	0.1	82	57	86	64
2,5-di-tert-amylhydroquinone	0.1	83	51	87	66
N,N'-diphenyl-p-phenylene diamine (DPPD)	0.1	90	67	93	68
6-phenyl-2,2,4-trimethyl-1,2-dihydroquinoline	0.1	80	42	88	65
a-tocopherol	0.1	43	0	59	0
	0.5	49	0	74	12
2,6-di-tert-butyl-4-methylphenol[1]	0.1	69	24	65	27
2-tert-butyl-4-methoxyphenol (BHA)	0.1	83	57	83	63

[1] Not of food-product grade.

Antioxidant mixtures used for stabilizing lard containing lecithin, BHA, citric acid, propyl gallate or BHT[b] in varying proportions in corn oil were tested. They were dissolved in hexane and applied in the concentration recommended for lard and in twice that concentration. No protective action was found.

BHA is an antioxidant which is permissible to use for many food products. The effect of this antioxidant on peppers of differing color stability is shown in Table 2.

Initial color of the sample was not correlated with the increased percentage retention caused by the antioxidant. With peppers of low color stability, BHA exerted a strong protective effect. With the very color-stable paprika, no protective effect was noted. The paprika was imported Spanish paprika, already ground when received. In a similar series using 0.1% of Santoquin, effect of the antioxidant was very marked with peppers of low or average color stability. With peppers which were very color-stable, the effect of the Santoquin was apparent only after several months, when considerable color loss had occurred in untreated peppers. Increasing the concentration of BHA from 0.1% to 0.5% for representative samples from these groups gave only an 8%–12% increase in color retention.

Antioxidant action of BHA may be increased by combination with BHT *(5)*. BHT when applied in concentrations of 0.1% or 0.5% was not an effective antioxidant with the peppers (Table 3). In combination with BHA, in equal proportions, antioxidant effect of BHA was decreased slightly rather than enhanced by BHT. Effect of increasing the concentration of

[a] Technical Contribution No. 226 from the South Carolina Agricultural Experiment Station, Clemson.

[b] Griffith Antioxidant G-5, G-4 concentrate type C and G-15.

TABLE 2

Color retention of peppers of differing color stability treated with 0.1% of BHA

Initial color concentration	Color retention at 37° C.			
	after 6 weeks		after 22 weeks	
	control	treated	control	treated
$K_2Cr_2O_7$ equivalents per gram of pepper	%	%	%	%
Unstable paprika				
.441	25	83	0	57
.435	52	80	20	52
.527	15	73	0	37
Stable paprika				
.398	87	88	57	61
Cayenne varieties				
.200	39	69	0	48
.374	67	89	25	60
Cayennes unstable as picked succulent ripe				
.429	45	83	0	63
.460	38	87	0	47
.300	55	88	17	55
.254	63	83	0	55
Cayennes unstable as picked at second harvest				
.215	39	80	0	48
.423	78	91	26	70

BHA or of BHA + BHT from 0.1% to 0.5% with the relatively color-stable cayenne in this series was similar to that found with the peppers in Table 2. With the very color-unstable paprika, increasing the BHA or BHA + BHT to 0.5% caused a more marked increase in color retention.

Addition of certain oils has been shown to increase stability of carotene in dehydrated alfalfa meal *(1,7,8)*. It was suggested *(1)* that the oil permits the natural antioxidants of the alfalfa to exert their maximum effect on carotene by bringing antioxidant and carotene into more intimate contact. Cottonseed salad oil[c] or mineral oil was dissolved in hexane and applied to the pepper by the same method used for the antioxidants at a concentration of 2%. Two percent of oil was found to be the maximum which could be applied without affecting the physical

TABLE 3

Retention of color in pepper on treatment with BHA and BHT Stored at 37° C.

Antioxidant		Color retention			
		paprika		cayenne	
		6 weeks	22 weeks	6 weeks	22 weeks
	%	%	%	%	%
Control	0	15	0	67	25
BHA	0.1	73	37	89	60
BHT	0.1	48	0	75	31
BHA + BHT (1:1)	0.1	69	22	78	50
BHA	0.5	81	56	93	69
BHT	0.5	59	0	78	37
BHA + BHT (1:1)	0.5	77	47	84	60

characteristics of the pepper. No increase in color stability of color-unstable paprika or relatively color-stable cayenne peppers so treated was found. Kansas workers *(7,8)* found that addition of oil with the antioxidant further increased stability of carotene in alfalfa meal. Addition of cottonseed salad oil or mineral oil at a concentration of 2% with BHA or BHT as in Table 3 did not increase the effectiveness of these antioxidants.

A very color-stable pepper was mixed with a very color-unstable pepper at a concentration of 10%. Addition of 2% of mineral oil or 2% of cottonseed salad oil to this mixture did not decrease the speed or amount of discoloration. Some peppers have been shown to contain natural antioxidants *(2)*. If the color stability of the added pepper was due to its natural antioxidant content, addition of oil did not extend its influence to color-unstable pepper.

[c] Wesson oil.

Concentrated hexane extracts of stable cayenne or paprika peppers, when applied to ground pepper in the same manner as the antioxidants (so that the concentration was equal to 5% of the dry stable pepper) had very minor or no protective action.

Treatment of peppers from New Mexico, California, and imported Spanish paprikas with 0.1% of Santoquin resulted in good color retention, on the same order as that observed in South Carolina grown peppers.

Varieties and strains of peppers follow the same general order in rate of discoloration at 25° C. as at 37° C. *(4)*. When treated with 0.1% of Santoquin or 0.1% of BHA and stored at 25° C., color retention was very good. Controls retained 0–40% of their color while treated samples retained 80–90% of their color over a nine-month period. At 5° C., 95–100% of the color was retained in treated peppers. It was not necessary to apply antioxidants at the time of harvest of the pepper. Samples were stored at 5° C. for 4 to 5 months before the antioxidant was applied. On subsequent 37° C. storage, the color retention in treated samples in contrast to untreated was on the same order as that with the treated and untreated freshly harvested peppers.

Preliminary tests with spraying the whole pepper, before drying and grinding, with the hexane-antioxidant solution indicated that color retention was on the same order as that obtained by spraying the ground dry pepper.

Cayenne or paprika peppers exhibit surface bleaching when exposed to ultraviolet light *(4)* or sunlight. For the sunlight experiment, ground peppers were put in thin layers on watch glasses and covered with a sheet of window glass. They were exposed to October sunlight outdoors. Peppers treated with Santoquin at a level of 0.1% were markedly resistant to bleaching (Table 4).

TABLE 4

Effect of ultraviolet light and sunlight on paprikas and peppers treated with 0.1% Santoquin

	Ultraviolet light			
	10 hr.	*24 hr.*	*72 hr.*	*120 hr.*
Untreated	+++ to ++++	++++	++++	++++
Treated	none[1]	none	+	++

	Sunlight		
	2 days	*7 days*	*16 days*
Untreated	+++	++++	++++
Treated	none	+	++

[1] Legend:
none: color as bright as the original
+ traces of discoloration
++ slight bleaching
+++ moderate bleaching
++++ totally bleached

There were no signs of organoleptic rancidity in any of the paprikas or cayennes treated with the effective antioxidants. Color was not altered from that of the original pepper at the time of application. Color loss observed over the months of storage resembled that of the untreated peppers; no off-colors appeared.

Peppers stabilized with 0.1% of Santoquin or 0.1% of BHA were tested with several recipes in which they are commonly used, (a) when the antioxidant was first applied, and (b) after storage at 37° C. for 6 months. No alteration in flavor or color was noted with treated paprikas when used as a garnish, in salad dressing, or in cooked dishes. Santoquin- or BHA-treated cayenne pepper when mixed with ground pork in proportions used for pork sausage gave no off-flavor when the mixture was fresh, nor after being frozen for four months.

DISCUSSION

Color stability in peppers was increased by antioxidants regardless of whether instability was due to variety, strain, or harvesting practices. The degree of instability of untreated peppers did not consistently affect the degree of protection afforded by the antioxidant. Although color is one of the criteria affecting the price

the producer receives, a bright initial color is not indicative of future color stability *(4)*. Peppers are often refrigerated to minimize color loss. After the pepper leaves the processor, however, there may be a period of several months in the grocery store and in the home, where temperatures are not controlled. Use of antioxidants is inexpensive and would insure grocer and homemaker a bright good color in a pepper or paprika. Antioxidants appear to preserve quality in general, and color is a factor in quality.

Santoquin has been disallowed by the Federal Food and Drug Administration for use in food. BHA is available in purified form suitable for use for food products. It is being used in many foods in which rancidity may affect the keeping quality. Use of antioxidants for foods is a relatively new field and it is likely that other antioxidants which increase the stability of the carotenoids will be approved.

SUMMARY

Loss of red color of paprika and cayenne peppers on aging was greatly reduced by spraying with certain antioxidants. Santoquin, DPPD, 2,5-di-tert-butyl-hydroquinone, 2,5-di-tert-amylhydroquinone, 6-phenyl-2,-2,4-trimethyl-1,2-dihydroquinoline and BHA were effective at a concentration of 0.1%. A-tocopherol or BHT were ineffective at a concentration of 0.1% or 0.5%.

Spraying the dry pepper with mineral or cottonseed salad oil did not increase color retention. Spraying with oil plus BHA or BHT did not increase the effectiveness of the antioxidant.

Peppers treated with 0.1% Santoquin were more resistant to discoloration by ultraviolet light or sunlight than untreated peppers.

No off-flavors or off-colors were found in various cooking tests with Santoquin- or BHA-treated peppers.

Acknowledgments

The authors are indebted to C. Ray Thompson, Western Regional Research Laboratory, for some of the antioxidants used in this study, and to J. H. Crawford and J. A. Martin of the South Carolina Experiment Station, Paul Smith, California Experiment Station, Roy Harper, New Mexico Experiment Station, The McCormick Company and the Pomona Products Company for the various samples of peppers used.

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Studies on Egyptian Dates. I. Yeasts Isolated from Souring Soft Varieties

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(Manuscript received April 7, 1956)

Dates are the most popular and the cheapest of all fruits in Egypt. They are commonly consumed in their soft "rutab" stage. In this stage, they are rich in sugar (about 34%) high in moisture content (about 60%) and easy to bruise during handling. Unless readily consumed, they are highly susceptible to yeast fermentation. Because of their limited storage life, they are disposed of in the market at low prices. Large quantities undergo yeast fermentation during marketing.

Very little work has been done regarding the presence of yeasts on soft varieties of dates. Melliger *(7)* working on what he called Amhat and Hayany dates, isolated some species of *Zygosaccharomyces* (syn. *Saccharomyces*) and *Saccharomyces* from the first variety and *Hanseniaspora*, *Mycoderma* (syn. *Candida mycoderma*) and *Torula* (syn. *Torulopsis*) from the second. Mrak, Phaff, and Vaughn *(9)* isolated 67 cultures of yeasts from spoiled samples of Californian and Egyptian dates. Most of these isolates were found to be species of *Zygosaccharomyces* and *Hanseniaspora*. A few isolates of *Pichia*, *Saccharomyces*, *Hansenula* and *Torulopsis* were also encountered. *Zygosaccharomyces japonicus* var. *soya* (syn. *Saccharomyces rouxii*) was the only yeast isolated from the Egyptian Amhat dates. Fellers and Clague *(5)* isolated a few unidentified species of *Torula* and *Wilia anomala* (syn. *Hansenula anomala*) from samples of soured Halawy, Sayer and Khadrawy dates imported from Iraq and Algeria.

The present work is a part of an extensive study which was carried out on the most perishable varieties of Egyptian dates; namely, Hayany, Amhat, Bent-Aicha, Samany and Ouraby. The objectives were to develop some methods for controlling spoilage and to make better use of these perishable varieties. The purpose of the present work was to isolate and identify the yeasts present on such spoiled dates. This work contributes also to our knowledge of yeast ecology.

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TABLE 1
The distribution of yeast isolates among the date varieties during the different years

Taxonomic designation	Year 1951			Year 1952		Year 1953					Total number
	Hayany	Samany	Ouraby	Amhat	Bent-Aicha	Hayany	Amhat	Bent-Aicha	Samany	Ouraby	
Hanseniaspora valbyensis	9	3	2		1	8	6	5	2	3	39
Candida guilliermondii	9	2	2	2	1	4	5	5	2	3	35
Candida tropicalis	1	1				2	2	2		3	11
Candida krusei	2										2
Candida mycoderma		1	1								2
Torulopsis inconspicua								1			1
Number of isolates	21	7	5	2	2	14	13	13	4	9	90
Number of date samples	9	4	2	1	1	7	6	5	2	4	41

EXPERIMENTAL

Forty-one samples of sour dates were collected from fruit-sellers in various districts of the city of Alexandria during the seasons of 1951, 1952 and 1953. All samples were of the most common soft varieties; viz., Hayany, Amhat, Bent-Aicha, Samany and Ouraby.

Isolation of yeasts was done by direct streaking and by crushing the dates in sterile wort (15° Balling) for 2 days before streaking a drop of the wort on propionate-wort-agar which was suggested by Mrak and Phaff *(8)*. The plates were incubated at room temperature (about 25° C.) until colonies developed. Purification was achieved by making three or more successive transfers from single colonies.

Identification of the yeast isolates was done by following the procedures of Lodder and Kreger van Rij *(6)*, with the following few exceptions. Durham tubes instead of Einhorn tubes were used in determining the fermentative ability of the yeast isolates, because of the greater sensitivity of the former as observed by Bouthilet *et al. (2)*. Yeast autolysate was used in the fermentation media since Bouthilet *et al. (2)* have shown that yeast extract may contain trehalose, which is fermented by some yeasts. Melibiose solution was prepared according to the procedure of Skinner and Bouthilet *(12)*.

RESULTS

Ninety cultures of yeasts were isolated from 41 samples of Hayany, Amhat, Bent-Aicha, Samany and Ouraby dates. The distribution of these isolates among the date varieties during the different years is shown in Table 1.

Thirty-nine of these isolates were sporulating yeasts and proved to be *Hanseniaspora valbyensis*. The rest of the isolates failed to produce ascospores. Fifty of these imperfect yeasts were classified as *Candida*. A single culture of *Torulopsis inconspicua* was also isolated.

DISCUSSION

Hayany dates are more abundant than the other varieties. Consequently, large numbers of samples were taken from this variety. This explains the relatively large number of isolates which were obtained from it.

Usually two and occasionally three different yeasts were isolated from each sample. The results presented in Table 1 show the homogeneity of the yeast flora of these soft varieties in different years. This was expected since all these varieties, at their rutab stage, have almost the same moisture and sugar content as shown by Ashmawy *(1)* and Ragab, El-Tabey Shehata and Sedky *(10)*.

Hanseniaspora valbyensis and *Candida guilliermondii* are the predominant yeasts present on soft varieties of Egyptian dates, as they were isolated from almost every sample of the different date varieties collected in different years. Five isolates were identified as *Candida mellibiosi* by using the key given by Lodder and Kreger van Rij *(6)*. However, since Wickerham and Burton *(13)* showed that this species is identical with *C. guilliermondii* the 5 isolates were placed in the latter species. *Candida tropicalis* occupies the next position, since a few isolates of this species were obtained from all the varieties examined.

These results show that the yeast flora of the soft varieties of dates is different from that of the dry and semidry varieties. The extensive work of Mrak, Phaff, and Vaughn *(9)* on California dates, which are mostly of the dry and semi-dry varieties, showed species of *Zygosaccharomyces* to be the most common yeast followed by *Hanseniaspora melligeri* (syn. *H. valbyensis*).

This difference of yeast flora in soft varieties of dates from that of the dry varieties might be expected since the two types of dates differ greatly in the kind of sugars present and in their moisture and sugar content. Fattah *(4)*, Ashmawy *(1)*, Ragab, El-Tabey Shehata and Sedky *(10)*, and Cook and Furr *(3)* have shown that the soft varieties, at their rutab stage, are of high moisture (about 60%) and low sugar content (about 32%) mostly of the reducing type. The dry varieties, on the contrary, are of low moisture (about 20%) and high sugar content (about 65%) mostly sucrose. The work of Mrak *et al. (9)* and that of Recca and Mrak *(11)* showed that *Hanseniaspora valbyensis*, *Candida guilliermondii*, *C. tropicalis*, *C. melibiosi* and *C. krusei* can not grow in a sugar solution of as high a concentration as species of *Zygosaccharomyces* are able to do.

Since no difference between the isolates obtained by direct plating and by the enrichment technique was noticed, the absence of *Zygosaccharomyces* species may also be due to low-sugar content of the medium used for isolation and/or to insufficient incubation period.

SUMMARY

Ninety cultures of yeasts were isolated from forty-one spoiled samples representing five soft varieties of dates growing in Egypt. Most of these isolates were found to be *Hanseniaspora valbyensis* and *Candida guilliermondii*. A few isolates of *Candida tropicalis*, *C. krusei*, *C. mycoderma* as well as a single isolate of *Torulopsis inconspicua* were also present. The absence of the haploid species of *Saccharomyces* may be due to the difference in the sugar content between soft varieties and the dry ones, or may have escaped the isolation due to short time of incubating the enrichment medium or to its low-sugar content.

Acknowledgment

The authors wish to express their thanks to Dr. E. M. Mrak and Dr. H. Phaff, Food Technology Department, University of California, Davis, for reading and correcting the manuscript.

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Studies on Egyptian Dates. II. Chemical Changes During Development and Ripening of Six Varieties

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(Manuscript received April 7, 1956)

Egypt rates sixth among the date growing countries of the world. Annual production in Egypt is about 400 thousand tons. Most of the dates produced are of the soft varieties. Because such varieties spoil rapidly, the major share of the annual production has to be consumed in a very short period.

Several investigators have reported on the chemical composition of different date varieties and on the factors that affect their composition. Vinson *(19)*, Fattah *(7)*, Hilgeman and Smith *(12)*, Rygg *(13)*, Cavel *(5)* and Ashmawy *(2)* investigated the changes that occur during ripening of several date varieties. Freeman *(9)*, Fattah and Cruess *(8)*, Sievers and Barger *(14)*, Hass and Bliss *(11)*, Barger *(3)*, Hilgeman and Smith *(12)*, Sinclair, Bartholomew and Bliss *(15)* studied the effect of incubation, locality, processing and storing, water injury, hydration, storage and soil fertilizers on the composition of dates, respectively. Vitamin content of various date varieties were determined by Smith and Meeker *(17)* and Smith and Farankop *(16)*. Cook and Furr *(6)* determined the sugars in 51 tree-ripe, date varieties growing in the United States.

There is a distinct lack of information on the chemical changes that occur during development and ripening of the soft varieties of dates. Therefore, the present study was undertaken to provide more knowledge about these varieties and to contribute to the development of methods for their preservation. Such methods should be of great economic usefulness in extending the market life of these products beyond the harvest season.

MATERIALS AND METHODS

The work reported in this paper was carried out on Hayany, Samany, Amhat, Zagloul, Siwy and Amry varieties. The first four varieties represent the most common soft varieties growing in Egypt whereas the last is a semidry variety. Siwy is a soft variety but requires somewhat hotter weather for its development.

All samples were obtained from the orchard of the Agricultural Experiment Station at Barage, near Cairo. By this means, several varieties of dates grown in the same type of soil, the same climatic environments, and subjected to the same soil treatment were obtained.

Since palm trees are usually artificially pollinated at 3 successive times, there exists a wide variation in the rate of development and ripening of dates on the same bunch. Therefore, Cavel's method of sampling *(5)* was used; namely, picking up fruits of approximately of the same size, colour and stage of development from scattered positions on the bunches.

Samples were picked at weekly intervals from July 22 to October 1 of 1951, always between 7 to 8 in the morning. The number of fruits per sample varied according to the stage of maturity, ranging from about 60 fruits during the early stages of development and decreasing gradually to as few as 30 for the last stage of maturity.

The fruits were immediately weighed after brushing off the dust and removing of the calyx. The seeds were then removed and weighed. The average weight of fruit, flesh, and seeds was calculated.

The terms suggested by Ashmawy *(2)* were adopted in characterizing the different stages of development and maturity, viz. *green*, *turning*, *fully coloured*, and *discoloured* or *rutab* stage. Fruits representing the first three stages were taken off the trees, whereas the fourth or "rutab" stage was obtained artificially by using Vinson's *(19)* method. This method is similar to the Egyptian native method. Samples from the rutab stage were taken for analyses every 24 hours for 3 successive days.

Moisture was determined by the vacuum oven method as described in A. O. A. C. methods *(1)*. The micro-method of Somogyi *(18)* was used for determining the reducing sugars. Inversion was accomplished with hydrochloric acid. Determination of tannin was done using the potassium permanganate method described in A. O. A. C. *(1)*.

RESULTS

Changes in weight. Results presented in Figure 1 show that in all varieties the average weight of the fruit increased gradually through the maturation period. The increase in weight from the beginning of the experiment, early during the green stage, until the fruit reached the fully coloured stage was approximately from 20 to 34% depending on variety. Regarding the weight of the fruits, Samany represents the heaviest

variety, followed by Amry and Zagloul, then Siwy and Hayany. Amhat is the smallest variety.

Figure 2 shows that the development of seeds varied in different varieties with a characteristic increase in the early period of development for all varieties. Although the Samany dates are the heaviest among the varieties studied, the ratio between the weight of their seeds to that of the whole fruits is the lowest among the varieties examined. The flesh of Samany dates represents a little over 90% of the weight of the fruit. Siwy variety rates the second in this respect, then Amry, Zagloul, Amhat and Hayany.

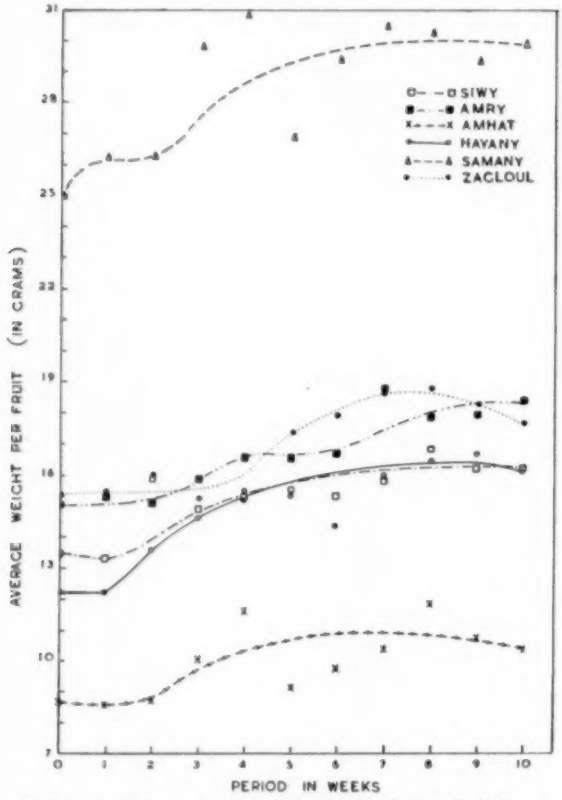

Figure 1. Changes in the weight of the fruits of different varieties during development and maturation.

Changes in moisture and total solids. As shown in Figure 3, the total solids of all the varieties examined remained almost constant through the early stage of development, i.e. the green stage. This was followed by a rapid rise in total solids during the turning and the fully coloured stages.

These results show a close similarity between Zagloul, Samany and Amhat varieties on the one hand and Siwy, Amry and Hayany varieties on the other. In the first group, the increase in total solids proceeds at a faster rate than in the other group, but all varieties attain almost the same percentage, about 40%, of total solids at their full maturity.

Formation and accumulation of sugars. Data concerning the changes in reducing, non-reducing and total sugars during the different stages of development for the various varieties of dates are presented in Figures 4 to 8.

During the early part of the green stage, reducing and non-reducing sugars remain almost at a constant level with reducing sugars predominating. Towards the end of this stage, a rapid rise in both sugars occurs.

Both reducing and non-reducing sugars continue to accumulate during the first part of the turning stage in all varieties except the Amry. In this latter variety, which is a semi-dry

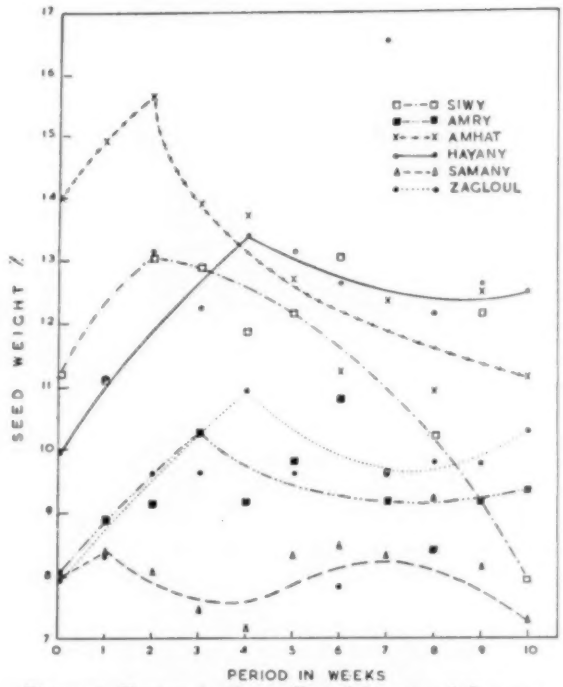

Figure 2. Changes in the seed's weight, presented as percentage of the whole fruit, during the development and ripening of different date varieties.

one, the reducing sugars reach the maximum early in the turning stage and start to decrease early before the other varieties. In the latter part of the turning stage, the non-reducing sugars continue to increase while the reducing sugars start to decrease.

The increase in non-reducing sugars and the decrease in reducing ones continue during the fully coloured stage till the ratio between the two types of sugars approximates one. In case of Amry dates, this ratio is reached earlier than the other

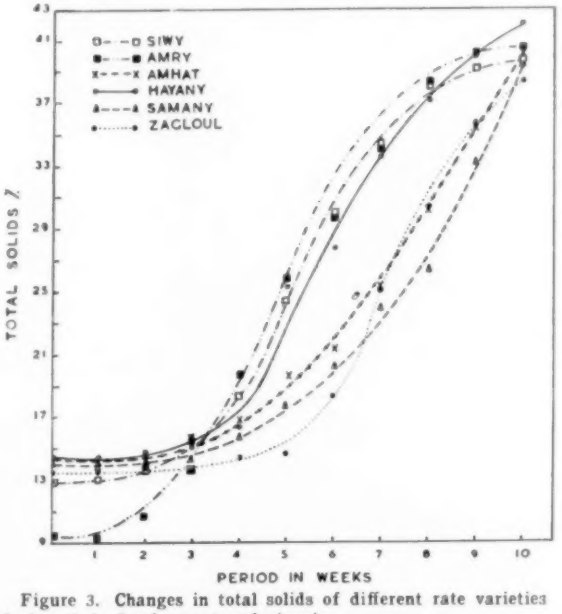

Figure 3. Changes in total solids of different rate varieties during their development and ripening.

varieties, since it is attained during the last part of the turning stage.

This general picture applies quite well for all the varieties examined, with the exception of Amry dates, with slight variations from one variety to another as shown in Figures 4 to 8.

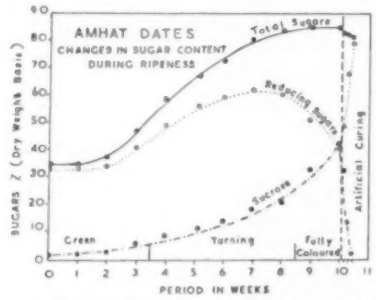

Figure 4. Changes in sugar content during development, ripening and artificial curing of Amhat variety.

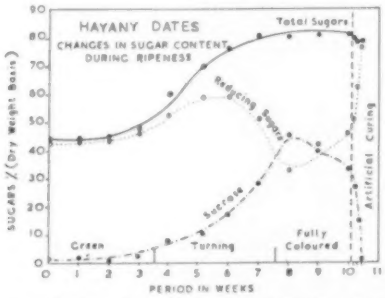

Figure 5. Changes in sugar content during development, ripening and artificial curing of Hayany variety.

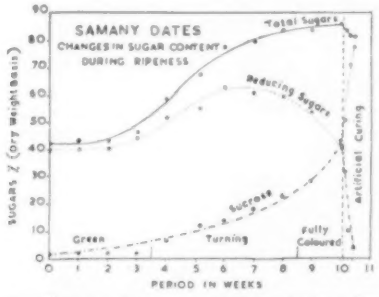

Figure 6. Changes in sugar content during development, ripening and artificial curing of Samany variety.

During artificial curing of the fully coloured fruits, rapid inversion of the non-reducing sugars proceeds very rapidly to such an extent that approximately all of the sugars present after 3 days are of the reducing type.

Changes in tannin content. Although the tannin content varies greatly in the different varieties during their green stage, it decreases during the ripening till it reaches almost the same level for all varieties at the end of the fully coloured stage as shown in Figure 9. Moreover, artificial curing causes more decrease in tannin content.

DISCUSSION

Climatic conditions in Egypt have developed three types of dates: dry, semi-dry, and soft. These types are described by Brown and Bahgat *(4)*. One date variety may belong to different types in different countries because of the environmental effect. According to Ghamrawy *(10)*, the Deglet Noor date grown in the Sudan behaves as a dry variety, while in Tunisia it is considered as a semi-dry date.

From the data presented on the weight of seeds in different varieties, it is shown that small fruits may have more flesh, on a weight basis, than larger fruits. This is quite clear in the case of Amhat and Hayany varieties since the fruits of the first variety are definitely smaller than those of the second variety. This finding is of economic value, particularly where additional product uses are involved.

Cook and Furr *(6)* reported that dry date varieties are generally rich in sucrose while soft ones contain large amounts of reducing sugars. Semi-dry varieties contain both sucrose and reducing sugars in varying amounts. Our results show that this is true if the soft varieties are in their rutab stage, but if they are in their fully coloured stage then the picture is quite different. As shown in Figures 4 to 8 the ratio between reducing and non-reducing sugars in the soft and semi-dry varieties examined is almost one at the end of their fully coloured stage.

The stages of maturity adopted in this work are based on colour changes. It is shown that during progressive tree-ripeness, colour changes are accompanied by

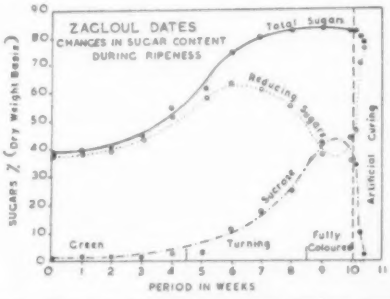

Figure 7. Changes in sugar content during development, ripening and artificial curing of Zagloul variety.

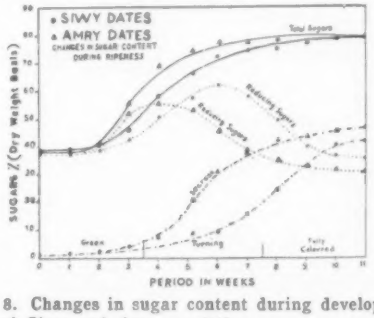

Figure 8. Changes in sugar content during development and ripening of Siwy and Amry varieties.

changes in the chemical composition of the fruits. The four stages of maturity for the soft varieties, may be characterized as follows:

The *green stage* is characterized by an almost constant level of total solids most of which are reducing sugars, a slow rate of accumulation of sugars, and a gradual decrease in soluble tannins.

The *turning stage* is characterized by a rapid increase in total solids which is due to rapid accumulation of non-reducing and reducing sugars. After reducing sugars reach a maximum, they start decreasing gradually; non-reducing sugars continue to increase. There is also a gradual decrease in soluble tannins with the colour turning to shades of yellow or red according to variety.

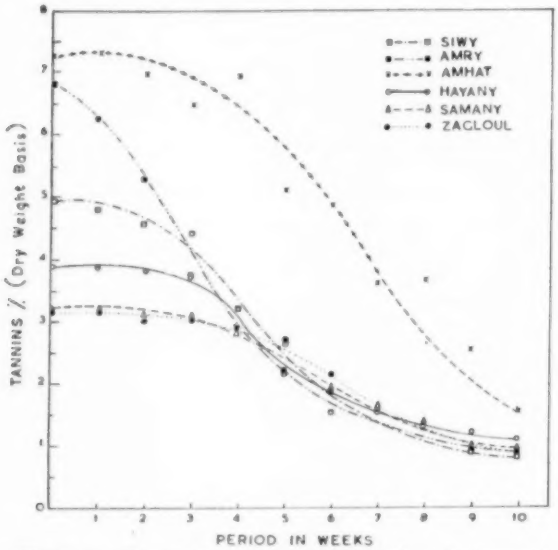

Figure 9. Changes in tannin content during development and ripening of different varieties of dates.

The *fully coloured stage* is characterized by a slow increase in the total solids and the ratio of reducing to non-reducing sugars becomes approximately one. The gradual decrease in tannin continues with the full development of yellow or red colours according to variety.

The *rutab stage* is characterized by a very rapid and almost complete inversion of non-reducing sugars. A sharp decrease in tannins and the development of mahogany, dark brown, or black colours in different varieties.

Since reducing and non-reducing sugars reach approximately the same level at the end of the fully coloured stage, this finding can be used as an index for complete ripeness.

According to Vinson *(19)* tannin in dates, exists principally in the outer layer of the fruits. Therefore, one should expect to find a positive correlation between tannins and the flesh content of fruits rather than between the sizes of the fruits of the different varieties. This correlation does exist, with the exception of Amry, in the green stage of all varieties examined where tannin is at its maximum concentration as shown in Figures 2 and 9.

SUMMARY

Compositional changes during the different stages of tree-ripeness were studied in six varieties of dates; namely, Amhat, Amry, Hayany, Samany, Siwy and Zagloul with regard to their flesh and seed weight, total solids, reducing and non-reducing sugars, and tannin content. The effect of artificial curing on these components was also investigated.

Throughout the different stages of ripeness, colour changes were found to parallel the compositional changes of each variety. In all varieties, sugars represent the main component of the total solids. The greatest increase of sugars occurs during the turning stage.

The ratio between reducing and non-reducing sugars could be taken as an index for ripeness since they reach approximately the same level at this stage.

Artificial curing resulted in a very rapid decrease in tannins and an almost complete inversion of non-reducing sugars.

Tannin content varies in different varieties but it decreases gradually during ripening.

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Treatment of Wheat With Ionizing Radiations. II. Effect on Respiration and Other Indices of Storage Deterioration [a] [b]

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(Manuscript received April 26, 1956)

TREATMENT OF GRAIN WITH IONIZING RADIATIONS produced by radioactive sources has frequently been proposed as a means of controlling insect infestation. Virtually no attention has been directed to the effectiveness of such means for preserving grain from fungal growth which is the major source of respiration as well as the cause of heating and chemical deterioration of grain in storage. Except for some investigation of germinative changes, little concern has been expressed for the possible effect of radiations on the technological and biochemical properties of flour produced from wheat so treated. That profound changes may occur in the gluten fraction of wheat subjected to ionizing radiations has been indicated in a previous investigation *(5)*.

The present study deals with the influence of gamma radiation treatment on the respiration and associated chemical changes, due primarily to storage fungi, of wheat maintained under conditions related to commercial storage.

MATERIALS AND METHODS

Wheat. A sound, high-grade sample of Hard Red Winter Wheat was used, grown on the Agronomy Farm at the Kansas Agricultural Experiment Station in 1954. This grain was of Concho variety, with a test weight of 62.6 pounds per bushel, moisture content of 8.3%, protein content of 14.0%, and germination of 96%. A quantity of wheat sufficient for all the experiments in this study was stored for use as needed in a cold room maintained at 50° F.

Conditioning of wheat to various moisture levels. Wheat was conditioned by direct addition of water followed by thorough mixing at periodic intervals for several hours.

Respirometers used for radiation treatment. The dimensional restrictions of the radiation facility at the Brookhaven National Laboratory where the radiation of samples was performed, dictated the size of the sample containers. These were fabricated from 18-gauge aluminum tubing 1¾ in. in diameter and 12½ in. long. Ordinary pipe bushings were welded to the ends. Into the inner threads of these were inserted brass nipples containing glass wool plugs in order to permit aeration of the contents for determining respiratory activity, while preventing contamination due to the entrance of microorganisms. During shipment and handling, the tubes were closed by ordinary ¼-in. pipe plugs. For assembly into the respiration train, these plugs were replaced with copper tubing attached by conventional threaded brass bushings.

Shipment and irradiation of samples. To prevent molding and deterioration of damp grain after conditioning and during shipment to and from radiation facilities (requiring periods up to 8 days), the tubes were packed in dry ice and shipped via rail or air express. Dry wheat when shipped for irradiation did not require refrigeration.

Measurement of respiration. For these studies the continuous respiration technique described by Milner and Geddes *(7, 8)* was used. The air thermostat was maintained at 30-31° C. Accumulated effluent air was analyzed for carbon dioxide and oxygen by means of the Haldane-Henderson technique, and gas exchange and respiratory quotient values were calculated as described in previous studies *(7)*.

Chemical and biological analyses. Fluorescence has been shown to be useful for evaluation of storage deterioration in commercial wheat since an increase in this value usually indicates that products of the Maillard or browning reaction are present *(3, 6)*. In the present study the fluorescence test used was based on the method published by Cole and Milner *(3)*. For this purpose the wheat sample was ground to pass through the No. 30 screen of the intermediate Wiley mill. A sample of 2 g. was extracted for 45 minutes with 15 ml. of 0.186 N. hydrochloric acid in a 100-ml. Erlenmeyer flask with shaking every 5 minutes. The mixture was then transferred to a 15-ml. centrifuge tube and a clear supernatant secured by centrifuging for 5 minutes and filtering through a Whatman No. 4 paper. Further clarification of the extract was accomplished by treatment with 5 ml. of chloroform and shaking vigorously for 1 minute. The resulting mixture was centrifuged again until perfectly clear. Two cubic millimeters of clear supernatant were transferred to 50 ml. volumetric flasks and diluted to volume with 0.186 N. HCl. Fluorescence measurements were made with a Coleman photofluorometer using B1-S and PC-1 filters. Sodium fluorescein (0.75 p.p.m.) was used to standardize this instrument, the dial being set at 60 with this solution.

Changes in protein solubility occurring due to the treatments employed in this study were detected by measurement of turbidity of potassium sulphate extracts of ground wheat samples. The method is that originally developed by Zeleny *(9)* and modified in this laboratory *(2)*. The detailed procedure is as follows: Two grams of freshly ground wheat sample are extracted in a 250-ml. glass-stoppered Erlenmeyer flask for 15 minutes using 50 ml. of 5% potassium sulphate solution. The extract is swirled at 5-minute intervals. After filtering through a No. 4 Whatman paper, 10 ml. of the extract are pipetted into a Coleman spectrophotometer tube containing 1.2 ml. of hydrochloric acid-sodium citrate buffer solution, pH 1.7. After standing for 20 minutes to attain maximum turbidity, percentage transmittancy of the sample was read on a Coleman spectrophotometer at a wave length of 550 mμ.

Fat acidity and moisture content were determined as outlined in *Cereal Laboratory Methods (1)* and seed germination was performed by the Kansas State Seed Testing Laboratory, Topeka, Kansas.

EXPERIMENTAL

The following major experiments were performed:

I. Effect of gamma radiation on respiration, germination, and chemical changes in wheat irradiated at 20% moisture content

For this study wheat freshly conditioned to 20% moisture content was maintained overnight in a refrigerator to permit equilibration. Eleven samples, each of 250 grams, were placed in the aluminum respirometers. These were packed immediately in dry ice for shipment via Railway Express to the Brookhaven National Laboratory, where the following treatments were applied at a dose rate of 319,000 rep per hour, using a Co^{60} source:

Sample Container	*Radiation Dosage rep* [c]	*Sample Container*	*Radiation Dosage rep* [c]
A-1	Control (0)	A-4	625,000
A-2	25,000	A-5	1,875,000
A-3	125,000	A-6	3,750,000

[a] Contribution No. 270, Department of Flour and Feed Milling Industries, and Contribution No. 4, Department of Chemical Engineering, Kansas Agricultural Experiment Station, Manhattan, Kansas.

[b] Presented at the Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956. This research is a portion of a thesis presented by Yin-Chao Yen as partial fulfillment of the requirements for the M.S. degree in Chemical Engineering at Kansas State College.

The control sample was shipped together with the others in order that it be exposed to the same conditions except for irradiation. Following this treatment these samples were repacked in dry ice and returned by air express. On arrival in Manhattan, one set of samples (A-1 to A-6) was placed in the respiration apparatus. The remaining set was opened and immediately dried with a fan at room temperature for subsequent chemical analyses. The aeration was started at a rate of 2 liters per day for each sample. At the termination of the 17-day respiration trial, all containers were opened and the grain immediately air-dried with a fan at room temperature.

II. Effect of dry ice treatment on respiration, germination, and chemical changes in damp wheat

The possibility that freezing and shipping of damp wheat in dry ice as in the first experiment might promote changes in the grain not related to the radiation treatment, indicated the need for a study of the effect of preliminary low temperature storage on subsequent damp wheat respiration and other properties. For this purpose 250-g. sub-samples of a lot of grain conditioned to 20% moisture content were stored in dry ice at −65° C. for 0, 89, 113, 137, 161, and 185 hours, respectively. Respiration and related measurements were then carried on at 30-31° C. for 21 days.

III. Effect of gamma radiation on wheat treated when dry and subsequently wetted to 20% moisture content

Wheat samples containing 12.4% moisture, which required no refrigeration during shipping, were subjected to the same radiation dosages as those in the first experiment. On return from Brookhaven one set of this series was conditioned with distilled water to 20% moisture content, maintaining sterile conditions, without removal of the sample from the container. After thorough mixing and storage in the cold room overnight the sample containers were placed in the respiration apparatus (30-31° C.) and respiration study was carried out for 10 days.

IV. Determination of narrow limits for radiation inhibition of wheat respiration

Radiation treatments with narrower differences than in the first experiment were applied to dry wheat at 12.4% moisture. The treated wheat was subsequently rewetted to 20% moisture using sterile technic and respiration values determined over a 12-day period at 30-31° C., to measure the survival of storage microorganisms.

RESULTS AND DISCUSSION

Irradiation of damp wheat. The effect of various levels of gamma radiation on the respiration of damp wheat at 30-31° C. after shipment in dry ice to and from Brookhaven, is shown in Fig. 1. The respiratory quotient values for the 17-day respiration trial appear in Fig. 2. Table 1 shows the effect on germination, fat acidity, fluorescence, and protein solubility (transmittance) of the treated material before and after the respiratory trial.

The graphical data of Fig. 1 indicate that the characteristic respiratory pattern of a developing mold population following an induction period of several days, such as is exhibited by the samples receiving 0, 25,000, and 125,000 rep is completely altered in samples receiving 625,000 rep or more, of radiation. This indicates the elimination of all fungal contamination in the 3 samples receiving the three highest dosages. The samples receiving 0, 25,000, or 125,000 rep on the other hand, attained approximately the same respiratory maximum and were about equally heavily molded at the end of the trial. Grey and grey-green fungal growth predominated, probably of the species *Aspergillus flavus* and *A. glaucus*, which earlier studies have indicated to proliferate under these conditions *(8)*.

Respiration values shown on the first day (Fig. 1) which were followed by decreases during the subsequent induction period, were in inverse order to the

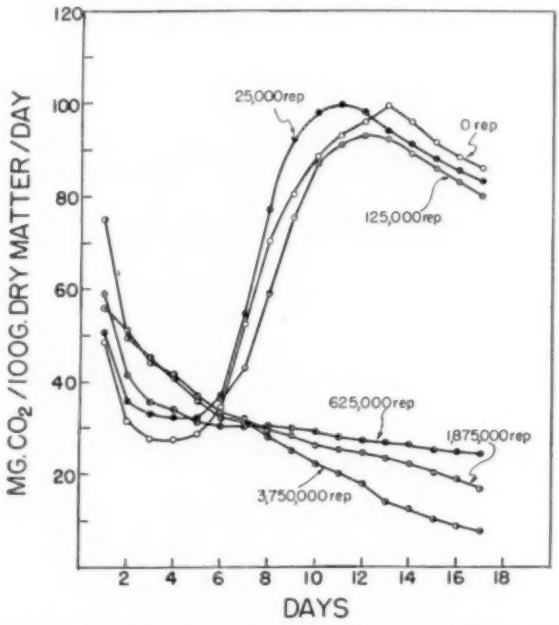

Figure 1. Influence of gamma irradiation and time on the respiration of damp wheat (20% moisture) at 30-31° C.

radiation treatment. Thus the higher radiation dosages, which prevented development of fungal respiration in direct proportion to dosage, caused a *stimulation* of initial gas exchange from the seeds. This respiration fell off with time, however, so that eventually the samples in which fungal activity was eliminated showed gas exchange characteristics *inversely* proportional to initial dosage.

Respiratory quotient values (Fig. 2), all of which originated at or near unity, tended to values of 0.9 or less in samples where the irradiation was insufficient to prevent mold development. This is in line with known characteristics of mold growth in damp grain *(8)*. On the other hand, irradiation levels which caused inhibition of mold growth and respiration resulted in markedly elevated R.Q. values up to 2.5.

The data of Table 1 show that gamma radiation in dosages as high as 3,750,000 rep caused no significant changes in the fat fraction as indicated by fat acidity values. Damp samples rendered sterile by such treatment showed no change in this factor even after 17 days of storage at 30-31° C., whereas samples that showed respiratory activity associated with mold growth had markedly elevated fat acidity values.

Viability of the damp seed was very sensitive both to radiation and mold growth. Complete elimination of germination was accomplished by dosages somewhat

[c] Roentgen equivalent physical: One rep is that amount of radiation resulting in the dissipation of 83 ergs of energy per gram of tissue exposed.

TABLE 1

Influence of gamma radiation on biological and chemical properties of damp wheat (20.0% moisture) before and after respiration trial for 17 days at 30-31° C.

Radiation dosage rep	Germination %		Fat acidity mg. KOH/100 g.		Fluorescence scale units		Transmittancy %	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Untreated dry wheat[1]	96.0		14.0		22.6		14.3	
0		7.0		53.0		23.6		17.9
25,000	88.0	2.0	16.4	57.0	19.3	22.8	16.9	16.9
125,000	10.0	0.0	16.4	54.0	19.1	22.8	16.3	17.2
625,000	0.0	0.0	16.4	17.0	21.0	24.8	16.9	21.1
1,875,000	0.0	0.0	15.6	16.0	24.0	31.4	18.1	30.0
3,750,000	0.0	0.0	15.6	16.0	28.0	40.4	19.6	44.3

[1] Moisture content 8.3%.

beyond 125,000 rep. Similarly the germination of the control sample, which was originally 96%, fell to 7% due to the toxicity of mold growth during the respiration trial.

Fluorescence, which showed only moderate increases at the higher dosages, was apparently unaffected by mold growth. On the other hand, the sterile samples receiving the greatest radiation dosage showed a significant increase in fluorescence with storage in the respirometer at 30-31° C. *in the absence of mold growth.* Fluorescence increases in wheat germ have been shown to be related to the development of non-enzymatic browning characteristic of germ-damaged wheat *(6)*. Decrease in protein solubility, as measured by increase in transmittancy, generally followed fluorescence changes, major effects being related to storage of heavily radiation-treated samples rather than to fungal growth.

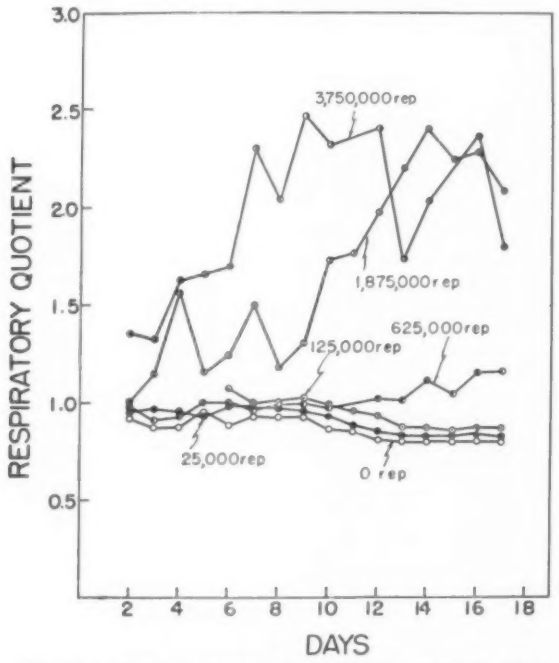

Figure 2. Daily respiratory quotient values of damp wheat treated with gamma radiation.

Influence of dry ice treatment. The influence of storing non-irradiated damp wheat, for various intervals at dry ice temperatures, on the subsequent respiration is shown graphically in Fig. 3. Clearly, the longer the period of storage at dry ice temperatures the lower the subsequent respiratory activity, whose pattern is characteristically that associated with fungal growth *(8)*. Respiratory quotient values for the first day of trial were elevated in proportion to time of low-temperature treatment. Thus the control sample showed an R.Q. of 0.82 on the first day, whereas the sample treated 185 hours had an initial R.Q. of 2.6. This phenomenon apparently reflects the activity of a decarboxylative mechanism in seeds promoted by wetting of the grain *(6)*. In every case, however, R.Q. values between 0.8 and 1.0 were associated with characteristic fungal respiration in damp grain *(8)*.

Another effect of extended low temperature treatment of damp wheat was a reduction in seed viability. Thus, after 161 hours the germination fell from 96% to 81%, and after 185 hours to 70%. This initial germinative loss was, of course, sharply intensified by the toxic effects of subsequent mold growth.

It was concluded from this study that the effects of exposure of damp grain to dry ice temperatures for periods involved in shipping the grain to and from the irradiation facility, while significant, were minor in comparison with the effects of the irradiation.

Irradiation of dry grain. The respiratory trend of grain irradiated at 12.4% moisture and then wetted by sterile technic to 20% moisture content is shown in Fig. 4. It is of interest that sterilization of the dry grain in terms of elimination of the respiratory pattern of storage fungi was accomplished at the same range of dosage as for damp grain, viz., between 125,000 and 625,000 rep. Less sensitivity of the biological agencies to the effects of radiation might have been expected in the drier grain but this did not prove to be the case here.

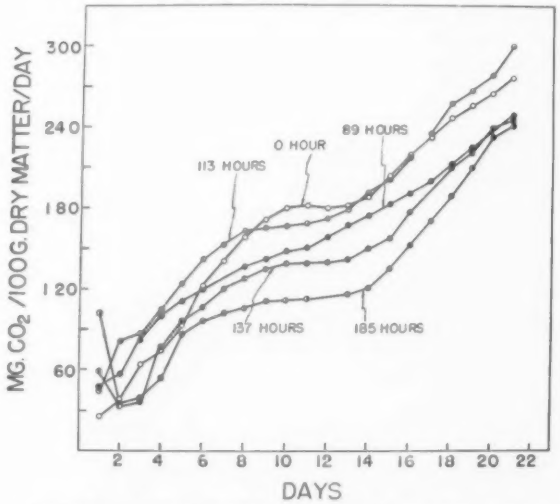

Figure 3. Effect of various exposures of damp grain to dry-ice temperatures on the respiration at 30-31° C.

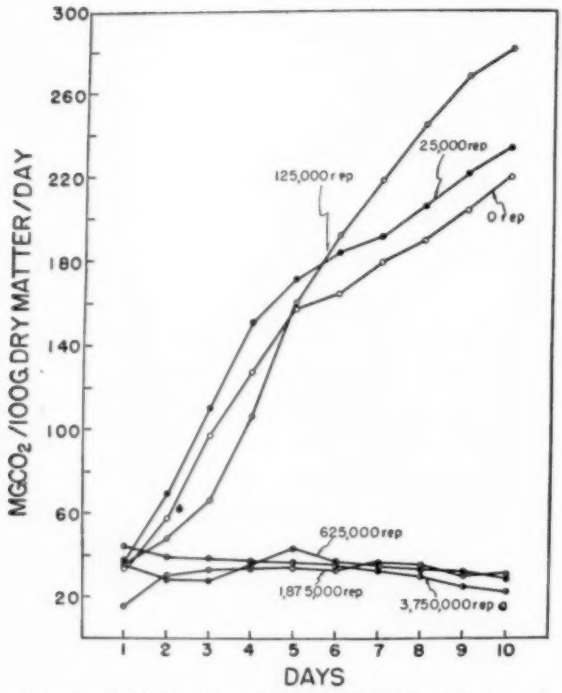

Figure 4. Effect of gamma irradiation of dry wheat (12% moisture) on the subsequent respiration when dampened to 20% moisture content, at 30-31°C.

Marked gas exchange due to seed metabolism prior to the onset of fungal respiration, as observed in the previous damp-wheat study *(5)*, was absent in this dry group. However, the elevation of respiratory quotient to values well beyond unity in grain sterilized at the two highest dosages as previously observed, was again noted in this study. At lower radiation levels, where sterilization was not accomplished, the typical R.Q. pattern due to fungal respiration (0.8 to 1.0) was immediately established.

The biological and chemical effects of the radiation treatment plus the subsequent respiration trial at 20% moisture are shown in Table 2. Part of the data for the 625,000 rep treatment are omitted because of contamination of the sample shortly after initiation of respiration trial. The data indicate that dry grain is considerably more resistant to viability losses due to radiation than is damp wheat, since some viability was maintained in the dry grain at dosages beyond 625,000 rep. As before, however, mold growth which develops in wetted, non-sterile samples, seriously damaged the germination.

Fat acidity, as in the previous trial, remained unaffected by radiation and increased only in samples insufficiently irradiated to destroy the fungi. Fluorescence changes due to irradiation did not occur until treatment level exceeded 625,000 rep. Thus fluorescence, which was initially 20.0 scale units, increased to 33.9 at the highest dosage (2,750,000 rep). After 10 days of mold growth, a minor increase in fluorescence from 20.0 to 24.4 units appeared. The elevated fluorescence in sterilized samples induced by heavy irradiation dosages increased with storage at high moisture content as in the previous studies. Changes in protein solubility due to radiation treatments below sterilization levels were minor, and the effects of subsequent mold growth were also minor in this regard. The two maximum dosages, however, produced a small but significant loss in protein solubility (as indicated by increased transmittancy) which was strongly intensified by subsequent storage of the sterile damp grain. Thus high levels of irradiation producing biological sterility, followed by dampening, resulted in more drastic changes in protein solubility than did dampening and mold growth under the same conditions of storage.

Closer limits for radiation sterilization. The effect of closely spaced radiation dosages (125,000 rep, 250,000 rep, and 500,000 rep) on the respiratory pattern of wheat treated when dry and subsequently re-wetted to 20% moisture content is shown in Fig. 5. At the lowest dosage of 125,000 rep, as in the previous trial, fungal growth was not inhibited as indicated by the respira-

TABLE 2

Influence of gamma irradiation of dry wheat (12.4% moisture), subsequently dampened to 20% moisture, on biological and chemical properties before and after respiration trial for 10 days at 30-31° C.

Radiation dosage rep	Germination %		Fat acidity mg. KOH/100 g.		Fluorescence scale units		Transmittancy %	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
0	96.0	9.0	16.0	72.0	20.0	25.0	18.0	15.8
25,000	92.0	7.0	15.0	72.0	20.0	24.4	16.6	15.5
125,000	70.0	4.0	16.0	63.4	20.2	24.0	16.3	17.8
625,000	33.0	0.0	15.4	.....	22.0	.....	16.1	.....
1,875,000	0.0	0.0	16.6	14.0	26.5	33.2	18.0	26.0
3,750,000	0.0	0.0	15.0	14.0	33.9	43.0	19.3	35.0

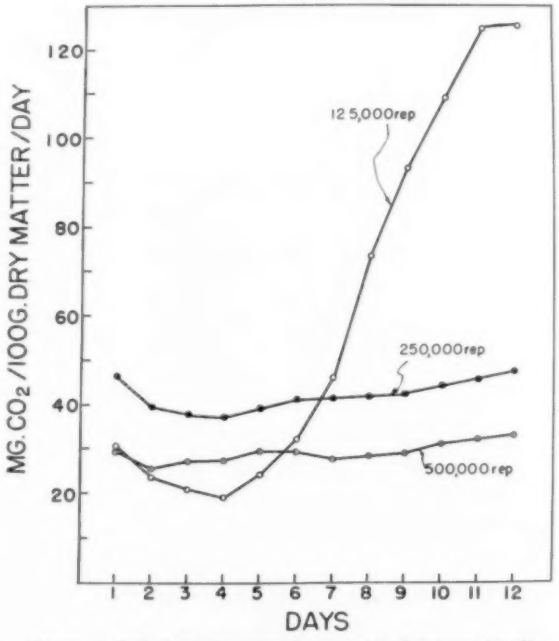

Figure 5. Influence of narrow increments of gamma irradiation dosages in the critical zone for respiratory inhibition. Wheat irradiated when dry (12% moisture) and subsequently dampened to 20% moisture for respiratory trial at 30-31° C.

tory pattern. At 250,000 to 500,000 rep an initial slight decrease in respiration during the induction period was followed by a very slow upward drift suggesting slow growth of some biological agency. If such existed, however, its activity was not reflected in any change in fat acidity. It may be concluded that, for all practical purposes, dosages of 250,000 rep or 500,000 rep eliminated storage fungi responsible for the typical respiration exhibited by damp grain.

CONCLUSIONS

The present study establishes that biological activity as reflected by respiratory exchange in damp non-germinating grain can be eliminated by treatment with ionizing radiations. The typical respiratory pattern accompanying the development of grain storage fungi is absent following minimum dosages of approximately 250,000 rep. Apparently moisture content of the grain in the range of 12 to 20% is not critical so far as mold sterilization by irradiation is concerned, although the germination of the grain is markedly more sensitive at the higher moisture level. The exposure of damp grain to dry ice temperatures for time intervals required to ship it to and from an irradiation facility apparently does not influence these results significantly although this treatment reduces seed viability as well as the maximum mold respiration levels.

A respiration response of the damp seed, as distinguished from that of the associated saprophytic fungi, was evident at higher treatment levels where fungi are destroyed. Thus the initial level of carbon dioxide evolution characterized by high R.Q. values that occur in the seed tissue *(6, 8)* appears to be stimulated by irradiation. As the carbon dioxide output falls to lower levels in sterilized non-viable seed, the R.Q. of the gas exchange remains at values well beyond unity. This suggests selective radiation inhibition of respiratory enzymes in the seed involved with oxygen uptake and, apparently, no effect of such treatment on the decarboxylative mechanisms. The maximum respiratory levels attained in non-sterile irradiated grain showed no relationship to the radiation dosage. This indicates that favorable environmental conditions for fungi are more important than initial fungal inoculum in determining ultimate levels of mold growth and respiration.

The stability of the triglyceride fraction of the grain to hydrolysis in the face of high radiation dosages is of interest in view of the great sensitivity of these compounds to normal biological deteriorative agencies. Oxidative damage to the lipids was not evaluated in this study although significant changes in the factor might be anticipated. It is significant also that other sensitive indices of chemical change such as protein solubility and fluorescence indicative of non-enzymatic browning are not noticeably affected until dosages of 625,000 rep or more are applied.

Since, as demonstrated in this study, fungi can be eliminated from stored grain by means of gamma irradiation, and inasmuch as insect life is destroyed at lower levels *(4)* the utility of the radiation procedures for wheat preservation appears encouraging. A subsequent report will indicate the influence of such treatments on the bread-making quality of wheat.

SUMMARY

The classical respiratory pattern reflecting growth of grain spoilage fungi on freshly dampened grain at ordinary temperatures is eliminated in hard winter wheat at moisture levels of 12% and 20% by treatment with gamma radiations in the dosage range from 250,000 to 625,000 rep. Respiratory quotient values accompanying the low and decreasing levels of respiration in radiation-sterilized grain were markedly elevated in comparison with the characteristic range of 0.8 to 1.0 which appears when molds proliferate in damp non-irradiated wheat and in wheat irradiated at levels too low to cause sterilization. A preliminary stimulation of gas exchange in damp seed tissue is caused by high radiation levels producing biological and germinative sterility in the grain.

Germination of wheat seeds was totally eliminated at 20% moisture content by dosages slightly beyond 125,000 rep but treatments greater than 625,000 rep were required to destroy viability in grain containing 12% moisture. Splitting of fats did not occur with dosages as high as 3,750,000 rep.

Fluorescence of grain extracts, which is considered to be an indication of sugar-protein interaction (non-enzymatic browning), was stimulated markedly by irradiation treatment at higher levels. Mold growth affected this value to only a minor extent. Maximum fluorescence increases occurred when radiation-sterilized, biologically inactive seeds were stored in the respirometers. Losses in protein solubility, measured by turbidity of saline extracts, paralleled fluorescence changes.

Acknowledgment

The assistance in this study provided by Dr. R. G. Taecker, Associate Director, School of Nuclear Science and Engineering, Argonne National Laboratory, formerly Associate Professor, Department of Chemical Engineering, Kansas State College, and by Dr. A. H. Sparrow, Brookhaven National Laboratory, is gratefully acknowledged.

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Yeasts Occurring in Brines During the Fermentation and Storage of Green Olives

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(Manuscript received March 12, 1956)

IN THE PREPARATION OF SPANISH-TYPE GREEN OLIVES in California, the fruit is harvested in the green to straw colored stages of maturity and placed in tanks, where the olives are treated with 1.25 to 2% lye, depending on the variety and the maturity of the fruit. This lye treatment is a debittering process, designed to hydrolyze and thus to eliminate most of the undesirable bitter glucoside, oleouropein *(1)*. When the lye has penetrated ½ to ¾ of the distance to the pit (depending on the variety) it is drained off and the fruit is leached several times with water.

Following the removal of most of the lye the fruit is covered with salt brine in the same tank (about 500 gallons) or in 50-gallon barrels. If the fruit is transferred to barrels, full strength brine (about 6.5% salt) is added and during the next 10 to 12 days more salt is added periodically to correct for the dilution caused by the aqueous phase in the olives. On the other hand, if the fruit is brined in the large vats, it is customary to retain the last wash water to minimize the loss of sugar and other soluble solids. Then salt is added to the water in relatively small amounts, each day for a week or more. The attainment of a full strength fermentation brine, therefore, is slow and occurs over a period of one to two weeks. These differences are shown clearly in Table 1.

TABLE 1

Characteristics of brine samples when collected

Date of sampling	Location of sampling	Temperature of Brine of Salt Concentration				NaCl/100 ml.		pH Value	
		Vat.		Barrel					
		°F.	°C.	°F.	°C.	Vat.	Barrel	Vat.	Barrel
Oct./6/50	Surface	63	17.2	63	17.2	.12	6.65	7.50	7.55
Oct./6/50	Center	63	17.2	63	17.2	.18	6.65	10.15	—
Oct./18/50	Surface	62	16.7	66	18.9	4.68	6.83	4.80	4.35
Oct./18/50	Center	62	16.7	66	18.9	5.27	6.39	5.65	4.29
Oct./30/50	Surface	67	19.4	67	19.4	6.33	6.30	4.40	4.20
Oct./30/50	Center	67	19.4	67	19.4	6.23	6.48	4.35	4.13
Nov./6/50	Surface	72	22.3	85	29.4	6.39	6.33	5.90	4.75
Nov./6/50	Center	68	20.0	70	21.1	6.58	6.46	4.22	4.06
Nov./14/50	Surface	—	—	—	—	—	—	—	—
Nov./14/50	Center	64	17.8	57	13.9	6.33	6.58	4.10	4.00
Nov./29/50	Surface	72	22.3	62	16.7	6.39	6.69	3.85	3.96
Nov./29/50	Center	69	20.6	53	11.8	6.23	6.65	3.88	3.96
Dec./12/50	Surface	73	22.8	62	16.7	6.41	6.51	3.82	3.98
Dec./12/50	Center	69	20.6	57	13.9	6.33	6.53	3.79	3.96
Jan./3/51	Surface	68	20.0	54	12.2	6.39	6.58	3.81	3.92
Jan./3/51	Center	64	17.8	44	6.8	6.30	6.59	3.80	3.92
Feb./2/51	Surface	—	—	—	—	6.39	6.66	3.84	3.90
Feb./2/51	Center	63	17.2	55	12.8	6.36	6.65	3.80	3.89

When the brines have attained full strength, the barrels are closed and stored in the open. Vats on the other hand are usually covered with a microcrystalline wax (sprayed on the surface in a melted condition). The vats are kept in a building where the temperature can be maintained at a more or less constant level (see Table 1). This reduces the time necessary for completion of the fermentation process. If the olives are fermented in barrels at natural outdoor temperatures, the time required for fermentation is obviously a function of the average day and night temperature and hence of the season of the year. If the pH value of the brine does not start to drop in 4 or 5 days, supplemental glucose or sucrose may be added to stimulate fermentation. The proper level of acidity calculated as lactic acid after fermentation in either barrels or vats should be in the range of 0.8-1.2%. The time required to reach this level may vary, however, from a minimum of 2 weeks to several months depending on the temperature and other factors influencing the fermentation. Greater details of the process are described by Vaughn *(12)* and Vaughn *et al. (11)*.

During fermentation and subsequent storage of olives, a yeast flora develops even in completely filled barrels and in vats with a surface covering. Although considerable information has been published by Etchells and co-workers regarding the yeast flora found during the lactic acid fermentation of cucumber salt stock *(3, 4, 5, 6, 7)*, very little is known regarding the yeast flora occurring during the fermentation of Spanish-type green olives.

Mrak and Bonar *(10)* found that the films on fermenting green olive brines contained *Mycoderma decolorans* (now called *Candida mycoderma*) and *Pichia membranaefaciens*. Both species grew well in the presence of 9.6% salt, but poorly in 15.2% salt. Both utilized 1% lactic, citric, tartaric, and malic acid and 0.25% acetic acid in a synthetic vitamin-free mineral medium. Izquierdo Tamayo *(8)* studied primarily the changes in bacterial flora during the fermentation of green olives in Spain. He stated that yeasts were present practically throughout the fermentation and that they presumably belonged to the genera *Pichia* and *Debaryomyces*.

It is apparent that there is much to learn about the yeasts occurring in olive brines, particularly about the subsurface flora. The present investigation is a first step in a program initiated to obtain more exact information regarding the species of yeasts occurring at the surface and in the center of fermenting olive brines in a commercial plant in California. It will be shown that the yeast flora is not constant in composition, but undergoes qualitative changes while the fermentation and subsequent storage progress. In addition the salt tolerance and ability to utilize acetic and lactic acids at various pH values of some of the predominant species was also studied.

EXPERIMENTAL

Brine samples were collected as described below from one vat containing olives of the Barouni variety and from one barrel containing Sevillano olives. The vat and barrel were part of a larger series in a commercial olive processing plant at Visalia, California. Approximately 200 ml. of brine were taken aseptically from the top and from the center of the vat and barrel at the time of filling and periodically during the fermentation until the olives were ready for packing. The exact dates of sampling are indicated in Table 1. The surface samples were taken by sterile pipette. The center samples were removed

as follows: A hole was drilled in the containers half-way between the bottom and the surface of the liquid. A glass tube was fitted in the hole by means of a rubber stopper and inserted to the center of the container. The end of the tube was closed by a piece of rubber tubing and a pinch clamp. The end was protected from the air by sterile cotton. Before taking a sample, about 100 ml. of brine was flushed through the tube. The samples were collected in sterile bottles and were received in the laboratory within 24 hours after removal from the tanks.

Direct streak cultures were made on plates containing malt agar (5° Balling), malt agar plus 6% salt, malt agar plus 15% salt and malt agar containing 0.5% calcium carbonate to detect possible acid producing yeasts. Since it was soon found that organisms growing on malt agar containing salt grew equally well or better on malt agar devoid of salt, restreaking for the purpose of obtaining pure cultures was done on normal malt agar. Incubation was done at room temperature (20-23° C.; 68-73.4° F.). Although lactic acid bacteria grow on malt agar, and purification of the yeasts is therefore somewhat more difficult, malt agar was preferred over certain less complex media since it was felt that some yeasts might be missed due to excessively slow growth. No difficulty was encountered in differentiating between yeast colonies and those of the lactic acid bacteria.

Procedures of Lodder and Kreger-van Rij *(9)*, supplemented for species of the genus *Hansenula* by the methods of Wickerham *(13)*, were used for identification of the isolates. Certain of the most common species were tested for their ability to utilize lactic and acetic acids under aerobic conditions and at various pH values, because Delmouzos, Stadtman and Vaughn *(2)* have shown that these acids predominate in normal fermented olive brines. The criteria for utilization of these acids were growth and pH changes in liquid cultures (Difco yeast nitrogen base) containing these acids as sole carbon sources.

RESULTS

A total of 170 yeasts were isolated from 33 samples of brine. The number of isolates of the various species of yeasts mentioned in Table *2* are the sum total of those isolated on all 4 media employed. The reason for this is that no clear-cut separation into specific groups was observed using these selective media. The only notworthy difference between the media was that malt agar containing 15% salt yielded few colonies as compared to the others and that growth was slow. In general

TABLE *2*

Number of cultures isolated at the time of filling the containers and after various periods of time during fermentation and storage

Organism	Periods of sampling in weeks[1]					
	Vat			Barrel		
	0	2-7	9-16	0	2-7	9-16
Candida parapsilosis (Ashf.) Langeron et Talice 1928	4	2	4	....	3	....
C. solani Lodder et Kreger-van Rij 1952	3	3	....	....	....	....
C. krusei (Cast.) Berkhout 1910	....	6	....	....	27	3[2]
C. mycoderma (Reess) Lodder et Kreger-van Rij 1870	....	....	1	....	6	4
C. tenuis Diddens et Lodder 1942	....	16	....	....	3	....
C. rugosa (Anderson) Diddens et Lodder 1917	....	....	....	....	2	1
Pichia membranaefaciens Hansen 1888	....	9	16	....	3	15
Torulopsis candida (Saito) Lodder 1922	1	....	....	....	....	....
T. sphaerica (Hammer et Cordes) Lodder 1920	....	11	....	....	....	....
T. magnoliae Lodder et Kreger-van Rij 1952	....	....	1	....	3	4
T. versatilis (Etchells et Bell) Lodder et Kreger-van Rij 1950	....	....	....	....	1	....
T. holmii (Jörgensen) Lodder 1909	....	2	....	....	1	....
T. etchellsii Lodder et Kreger-van Rij 1952	....	1	4	....	....	....
T. inconspicua Lodder et Kreger-van Rij 1952	....	....	....	....	....	1
Pullularia pullulans (de Bary et Löw) Berkh. 1886	2	....	....	....	....	....
Rhodotorula glutinis (Fres.) Harrison 1852	2	....	....	....	....	....
Debaryomyces nicotianae Giovannozzi 1939	....	2	....	....	....	....
Hansenula subpelliculosa Bedford 1942	....	1	....	....	2	....

[1] Isolations were made at the start and after 2, 3, 4, 5, 7, 9, 12 and 16 weeks.

[2] These 3 isolates were all obtained from the 9 week sample.

Pichia membranaefaciens could tolerate higher salt concentrations than could species of *Candida*.

Forty-eight of the isolates were sporulating yeasts, namely 43 of *Pichia membranaefaciens*, 3 of *Hansenula subpelliculosa*, and 2 of *Debaryomyces nicotianae*. The remainder (122 isolates) were considered to be asporogenous yeasts. Of these, 88 were species of *Candida*, 30 of *Torulopsis*, and 2 each of *Rhodotorula* and *Pullularia*. The species represented are listed in Table *2*. It is apparent that most of the organisms isolated belong to the two genera *Candida* and *Pichia*. Of the 6 species of *Candida*, the species *Candida krusei* was found most frequently. *Candida mycoderma* (11 isolates) can be considered as the imperfect form of *Pichia membranaefaciens*, since the cultures were identical in all respects, except that no spores could be detected in the former. This relationship between the two species was emphasized also by Windisch *(14)*. The distribution of species was quite similar regardless of whether samples were collected at the surface or in the center of the container. This is not too surprising, since in the plant where the experiments were carried out, every effort was made to keep the conditions of the fermentation as anaerobic as possible. In other words, the barrels were kept completely filled and the vats had a layer of wax on the surface. Thus, a typical layer of surface yeast scum was absent in this plant. The florae found in the vat and in the barrel were qualitatively similar as far as the predominant species were concerned.

Changes in yeast flora. One of the most important factors with respect to the occurrence of certain species of yeast was the time after the start of the fermentation at which the brine samples were collected (see Table *2*). Since the salt content of the vat is very low at the start (0.12%) *T. candida*, *Rh. glutinis* and *P. pullulans* have probably little significance in the brine flora. They occurred only in the starting sample of the vat and not at all in the barrel, where a high concentration of salt (6.65%) was introduced at the very beginning. In fact, no yeasts were isolated from the starting brine in the barrel. Moreover, the 3 species mentioned above are strictly oxidative and the condition in the containers was for the most part anaerobic, thus preventing their further growth. On the other hand, all other species (with the exception of *C. rugosa*) had fermentative power, even though very weak in some cases (e.g., *P. membranaefaciens* and *C. mycoderma*). This group, therefore, has the potential ability to grow slowly under anaerobic conditions, provided sugar is available and the acidity and salinity are not inhibitory.

Several species were found only during the first period (2-7 weeks) during which most of the sugar is converted to organic acids (see Table *2*). These species disappeared entirely or nearly entirely during the last period (9-16 weeks). Since the salt content was approximately the same during these two periods, it is most likely that conversion of the sugar to lactic acid was the principal cause for their elimination. These species were *C. krusei*, *C. tenuis*, *C. solani*, *T. sphaerica*, *T. holmii*, *T. versatilis*, *H. subpelliculosa* and *D. nicotianae*. With the exception of the last species which ferments weakly, all the other species (79 isolates) ferment one or more sugars strongly.

Another group of species occurred only in the last period of fermentation and storage or was found in both periods but with a tendency to become distinctly predominant in the last period. These species were *P. membranaefaciens*, *C. mycoderma*, *C. rugosa*, *T. inconspicua*, *T. magnoliae* and *T. etchellsii*. It is noteworthy that the first 4 species (58 isolates) all ferment very weakly and are primarily oxidative yeasts. The minority (13 isolates), represented by the last two species, can ferment one or more sugars.

The position of *C. parapsilosis* in this scheme is not clear. In the vat it was found from start to finish, but in the barrel only in the period from 2-7 weeks.

Salt tolerance. Although the salt content of olive brines is not high and considerably lower than that in most cucumber brines *(6)*, a few tests were made to determine the approximate salt tolerance of the two most numerous species *C. krusei* (early period) and *P. membranaefaciens* (late period). It was found that the former did grow on malt agar containing 5% salt, but not in the presence of 10% salt. The latter grew equally well

in both concentrations of salt. It might be mentioned that no cultures of *Candida* were isolated from plates containing 15% salt, whereas a few of *Pichia* were obtained from this medium. The relatively low salt tolerance of *C. krusei* has been demonstrated before *(4)*.

Acid production. All isolates of the predominant species were inoculated (pinpoint) on petri dishes containing yeast autolysate with 5% glucose and 0.5% chalk. The plates were examined after 11 days. None of the isolates showed a zone of clearing around the colonies. Thus, the principal part of the flora cannot be considered a contributing factor to the production of organic acids in the brine.

Utilization of lactic and acetic acid. Ten cultures each of *P. membranaefaciens* and *C. krusei* were inoculated into tubes containing Difco Yeast nitrogen base and 0.6% of lactic or acetic acid to determine the utilization of these acids. The pH was adjusted by addition of NaOH and checked after autoclaving in control tubes. For lactate the pH was varied from 2.65 to 5.90 and for acetate from 3.20 to 6.55. Cultures of both species grew well in the lactate media, although slower at pH 2.65 and 3.00 and the changes in pH due to growth were slight. At pH 4.0 and higher growth was rapid and the pH of the medium increased to near neutrality in one week. In the case of acetate the 10 cultures of *P. membranaefaciens* grew in a similar manner as with lactate, but the cultures of *C. krusei* did not grow at pH 3.2. At pH 4.1 growth was rapid and the pH of the medium was raised to neutrality in 7 days. It is apparent that under aerobic conditions the main species can utilize the organic acids important in the production of green olives, thereby increasing the pH to the point where spoilage organisms can take over. This is apt to happen if a surface film is allowed to form. There is no information in the literature indicating that yeasts are able to utilize organic acids for growth under anaerobic conditions. However, further studies are desirable to substantiate this point. The question remains as to whether or not the yeasts contribute growth factors for the lactic acid bacteria or whether they contribute or detract in any way to the flavor of the finished product.

DISCUSSION

The survey presented here is primarily of a qualitative nature, since no quantitative population studies were made. It was felt preferable to establish first what principial species of yeast occur in olive fermentations. With this knowledge on hand, it may become possible in further studies to use selective media and establish quantitatively the extent of the populations of various species. Yet certain trends are obvious, showing a change in population from the period during which the sugar is actively converted to lactic acid and the later storage period during which the lactic acid fermentation is essentially complete. With the data at hand, the most plausible explanation of this change would seem to be the fact that during the first phase fermentable sugar is available in the brine and with anaerobic conditions prevailing, the strongly fermentative yeasts have a selective advantage. They would therefore be expected to form the predominant flora, which is supported by the experimental evidence. During the second phase, when the fermentable sugar is largely exhausted, their active multiplication is impeded. Since no quantitative population studies were made it can not be decided at the present time whether these yeasts die off slowly or whether they become relatively insignificant in numbers (perhaps due to settling out) when the more oxidative flora, exemplified by *P. membranaefaciens* and *C. mycoderma*, begins to increase probably at the expense of the lactic acid and other substrates not fermentable by yeasts. Even though the amount of oxygen available is very limited, respiration is a much more efficient dissimilatory process for growth than is fermentation, and thus it might account for the development of the oxidative flora in the last period.

The salt content probably does not play a role, because it is essentially constant at the 6.5% level from the second week on. This is quite different from certain cucumber fermentations where the salt content is increased over an extended period to a much higher level. Furthermore the initial sugar content is usually lower in the case of olive fermentation. Besides these differences, the vats used for cucumber fermentation are much bigger, thus securing a more strictly anaerobic system for the subsurface yeasts. In the case of cucumbers, the surface flora is often completely eliminated by exposing the surface of the brine to the sun. In spite of these differences and the much more extensive results of the North Carolina group, a very limited comparison of the two fermentations might be made. Some yeasts although not the major species, were found in both fermentations. For example, the only species of *Hansenula* found by us was *H. subpelliculosa* and this was the only species of *Hansenula* found by Etchells and Bell *(5)* in the subsurface flora of southern cucumber brines (North Carolina) and in the Northern areas by Etchells, Costilow, and Bell *(6)*. In the last area it was found consistently in 3 different States and during three pickling seasons. *Torulopsis etchellsii* (syn. *Brettanomyces sphaericus*, Etchells et Bell, 1950) was found in small numbers in olive brine by us and similarly as a minor part of the yeast flora in cucumber brine by Etchells *et al. (4)*. In both cases it occurred towards the end of the fermentation. Other yeasts in common between the two fermentations were *T. versatilis* (syn. *Brettanomyces versatilis*, Etchells et Bell, 1950) and *T. holmii*.

From an ecological point of view such data are of interest, since it offers useful information as to where strains of certain species of yeast may be isolated at will.

SUMMARY

A qualitative survey was made of the yeasts occurring in commercial olive brines during fermentation in a vat and in a barrel over a period of 16 weeks. Surface growth was prevented as much as possible. Samples were taken from the center and from the upper layer of the brine but the flora was essentially similar. A total of 170 yeast cultures were isolated and identified. After active lactic acid fermentation was over (about 7 weeks), a marked change in yeast flora occurred. During these 7 weeks, a predominantly fermentative yeast flora was present, the principal species being *C. krusei*, *C. tennis*, *C. solani*, *T. sphaerica*, *T. holmii* and *H. subpelliculosa*. During the second period (9-16 weeks), besides certain fermentative yeasts which persisted from the first period, a more aerobic flora was found. The principal species were *P. membranaefaciens*, *C. mycoderma* and *C. rugosa*. The main species of the first period *(C. krusei)* and that of the second period *(P. membranaefaciens)* were both able to utilize lactic and acetic acids under aerobic conditions and pH values prevailing in olive brines. The principal species men-

tioned in either of the two periods did not produce acids on chalk agar. The yeast flora in fermented green olive brines has been compared with the flora of fermented cucumber brines studied by other workers.

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Retention of Taste Sensitivity[a]

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(Manuscript received June 21, 1955)

Increasing interest has been shown in the past several years in applying organoleptic methods to control food processing. Pioneers *(3, 6, 8)* in the field provided dependable systems to measure similarity.

The duo-trio method of analysis was installed in the quality control laboratories of Schenley Distillers, Inc., in May, 1951. One objection which could be raised in utilizing this procedure, however, is the relatively inefficent use of the observers' time and ability. Even when "professional" subjects are employed, the usual duo-trio procedure is wasteful. Where observers are recruited from the regular work force and duty as a participant on a tasting panel is only a part of the job requirement, it is imperative that a more efficient plan be developed. Necessity, therefore, forced an investigation to determine whether or not four judgments as obtained by an expansion of the duo-trio method could be as reliably obtained as two. Experiments conducted at several different Company laboratories showed conclusively that four observations could be made at one session—which were equivalent in all respects to the two originally thought optimum. We have identified this procedure as the quadro-trio.

Logically, the next question to be determined was whether or not sensitivity could be retained beyond the four judgment position. If, for example, six observations could be made validly at one session, our program would more nearly fit into a production line operation.

Pfaffmann, Schlosberg and Cornsweet *(7)* have noted sensitivity retention over a 40-minute period using non-alcoholic products. Other studies *(1, 2, 4)* have been made comparing the relative merits of one procedure with another. When this problem was undertaken in the spring of 1955, we were unable to find any reference to discriminating ability using a duo-trio technique beyond the four judgment position. We note, however, in March of 1956, Mitchell *(5)* reported success with five consecutive trio judgments on beer.

[a] Presented at the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 15, 1955.

EXPERIMENTAL

A great variety of products is processed by the Company and, therefore, any control system adopted must be universally applicable to these beverages. Therefore, we selected as representative—blended whiskey, straight whiskey, gin, beer, and vodka.

Test procedure consisted of a series of 6 trios—standard, sample one, and sample two. Each sample was offered after a 10-second interval. A recovery period of 20 seconds was permitted between each trio, during which a neutral water rinse was requested. A "conditioner" or "warm-up" was offered to open the study.

Pre-test advice included the instruction that the entire quantity presented was to be taken into the mouth. No swallowing was permitted. The sample which matched the standard was recorded.

Various mechanical problems arise with the introduction of the multiple trios. As no identification is used, great care must be taken by the technicians in order that samples are not intermingled. The multitude of glasses required on each test might well become a serious problem; therefore, a minimum handling of soiled glassware is imperative.

Quantity, color, temperature, and concentration, as well as order of presentation, were carefully controlled. The true standard was not always maintained in the standard position and was alternated with the experimental sample in random order. Brewer Pipetting Machines dispensed the 4 ml. quantities offered the observers. Three-fourth ounce "shot" glasses of a uniform shape, together with hydrometers and glass cylinders, completed the equipment required.

The series of tests was conducted without regard for time of day—except that a short interval was allowed after beginning and before dismissal times.

Both men and women participated, and no attempt was made to organize the panels according to age groups. Panel selection was based on taste proficiency over an extended period. Al-

though no special effort was made to motivate the chosen panels, advice was given that special work was in progress.

As previous experience has shown that with the introduction of a new procedure, initial results are undependable, a short training program was employed to enable observers to obtain a certain degree of familiarity with the new procedure before test data were collected.

After each group of 6 judgments was obtained, the observer had the opportunity to determine his score.

Design of the experiment specified 300 judgments on each pair of samples.

Alcohol exerts a desensitization if served in high concentration and in large volumes. Intensity of flavor in the various products, too, may lessen perceptive ability. In order to minimize the influence of these factors, dilutions were made in the 4 products of higher alcoholic mixtures. Concentrations of alcoholic strength are expressed in degrees of proof. A 100 proof solution contains 50% alcohol. Straight whiskies were reduced to 25 proof; while blended whiskies, gins and vodka were diluted to 45 proof.

Beer was tested as originally packaged since the alcoholic content was approximately 5%. Pairs of beverages compared in each case were designed to be different in order that the effect of increased exposure could be measured.

RESULTS AND DISCUSSION

The experimental series produced the following data:

TABLE 1

Straight Whiskey[1]

Duo-Trio	N	N Correct	σ p**
1	100	79	5.7
2	100	69	3.8
3	100	75	5.0

[1] Straight whiskies are defined as 100% whiskey; while blended whiskies are a combination of straight whiskies and grain neutral spirits.

** $\sigma p = \frac{\%\ \text{correct responses} - 50\%}{\frac{50\%}{\sqrt{N}}}$

(Significant difference = 2.2 σ p)

TABLE 2

Gin

Duo-Trio	N	N Correct	σ p
1	90	66	4.4
2	90	65	4.2
3	90	67	4.6

TABLE 3

Beer

Duo-Trio	N	N Correct	σ p
1	100	64	2.8
2	100	70	4.0
3	100	65	3.0

TABLE 4

Blended Whiskey

Duo-Trio	N	N Correct	σ p
1	100	75	5.0
2	100	75	5.0
3	100	71	4.2

TABLE 5

Vodka (Colored) Versus Blended Whiskey

Duo-Trio	N	N Correct	σ p
1	100	76	5.2
2	100	77	5.4
3	100	80	5.8

In each series checked, significant differences were found between respective pairs whether in duo, quadro, or sextuple trio. On gin, beer and vodka, a higher σ p rating was obtained on the third duo-trio than on the first.

Additional trios did not adversely affect an individual's perception, whether he was an "average" or a "superior" taster.

As a general rule, we would recommend for control purposes, a panel of 10 different people rather than five. Standard operating procedures at Schenley specify, in the sextuple trio, three different pairs of samples presented in ascending flavor intensities.

From the data obtained, it was concluded, therefore, that we might safely proceed with the use of the sextuple trio. Further experience on the effectiveness of the multiple trio procedure, has strengthened our confidence in the original work. During the past year, we have obtained approximately 75,000 judgments on all products practicing this system. One decided advantage, gained by adoption of this technique, was that great flexibility was provided the quality control laboratories during peak demands. Either the quadro-trio or the sextuple-trio may be utilized as the situation requires. The additional minute and a half needed for two more judgments does not constitute a serious infringement on the regular duties of the observer.

SUMMARY

Data collected from experiments with five different products ranging in intensity from a low threshold to a high threshold have shown conclusively that the sextuple trios are reliable, workable, and efficient from these points of view: individual discernment and mechanical ability for adoption.

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Study of Consumer Preference of Salt and Sugar Levels in Canned Green Beans

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(Manuscript received December 7, 1955)

CANNERS OF VARIOUS VEGETABLES are known to use salt-sugar brines of varying concentration. Levels of salt and sugar used in the brines of commercial packs of vegetables are selected either by what is believed to be standard practice or by personal preferences. The range in salt and sugar concentrations in brines even in one type of canned vegetable is quite large. A survey of fifteen canners of green beans indicated that a range of salt from 1% to 2¾% was being used, and the average concentration was 2.1%. Although several processors had added sugar, currently none were adding sugar to canned green beans.

Information about the level of salt and sugar in canned vegetables preferred by consumers is scant. Langwill *(5)*, in a study of taste perception and preferences, noted a greater preference of both men and women for moderately sweet and salty food. The present study was undertaken to ascertain whether a certain level of sugar and salt in canned green beans was preferred by consumers.

EXPERIMENTAL

Green beans of the variety Refugee were selected from growing areas near Coleman, Wisconsin. The beans were harvested in the usual manner and processed in a commercial cannery. Size graded cut No. 4 beans *(6)* were selected from the line for the study of consumer acceptance of salt and sugar levels. The cut beans were filled into cans of 303 diameter in the usual manner, then brine solutions of known salt and sugar concentrations were added at the time of filling. Four concentrations of sugar (0-4%), four of salt (0-4%), and combinations of each were separately used as the brines for the beans. The canned beans were stored at 45° F. until used for flavor evaluation.

Evaluations were conducted in grocery stores throughout the city of Madison, Wisconsin. A team of two supervisors offered the samples to customers during one-week intervals. All sampling was at random, and the responses of the customers voluntary. Two samples of warmed beans in individual clean paper cups, each containing a plastic spoon, were given to the taster. The participant was asked to taste the green beans and to indicate a preference. The response was designated on a card along with the sex and approximate age of the taster. The first 25 pairs of samples were presented in one order, and the next 25 in the reverse order *(4)*.

To preface the taste tests, a poster was displayed which designated the test was being conducted by the University of Wisconsin in conjunction with the store.

In addition to the store evaluations, coded cans were given to selected persons to take home for comparison of the green beans during a regular meal. Participants were asked to report their ratings within one to two weeks by postcard *(3)*. Also, a selected panel of 6 men and 6 women were asked to place in order of their preference, the first 5 samples most suitable to their taste.

RESULTS AND DISCUSSION

A total of 184 comparisons was made, involving approximately 9800 individual taste evaluations. Results of these evaluations are presented in Figure 1. Each symbol represents 50 flavor evaluations of one sample against another. Selected replicate tests of several samples closely repeated the original tests. The boldly printed arrow (Figure 1) designates an evaluation of preference by the consumer which is statistically significant at the 5% level of significance using the tables of Cochran *(2)*. Thirty-three favorable of 50 comparisons indicates preference. Greater than 33 of

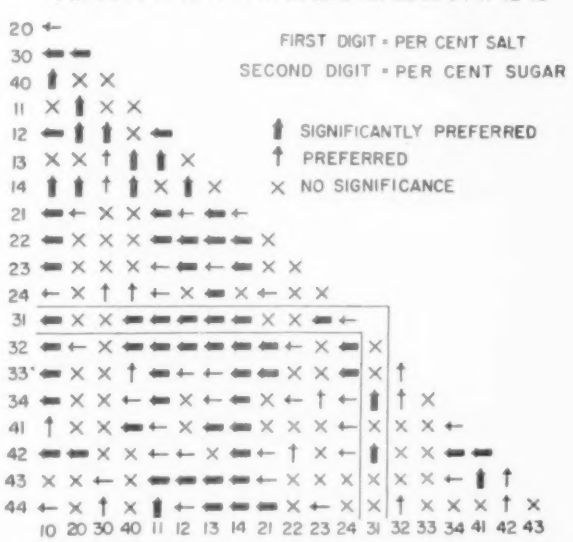
10 20 30 40 11 12 13 14 21 22 23 24 31 32 33 34 41 42 43
FIRST DIGIT = PER CENT SALT
SECOND DIGIT = PER CENT SUGAR
SIGNIFICANTLY PREFERRED
PREFERRED
NO SIGNIFICANCE

Figure 1. Tabulation of evaluations by consumers of canned beans containing varying levels of salt and sugar. Each symbol represents results of 50 evaluations of one sample compared with another.

the 50 tasters preferred the sample (coded for reference) toward which the bold arrow is pointed. The lightly printed arrow represents a slight preference. The lightly printed arrow represents the preference for the sample toward which the arrow is pointing by 30-33 of the 50 tasters. An X mark represents chance selections, or comparisons wherein the samples were not differentiated by the consumer. The samples were coded by two digits. The first digit is the percentage of concentration of salt in the brine, the second of sugar.

Results of the flavor evaluations conducted by duo test in stores indicate that green beans packed in brine containing 3% of salt were preferred when compared to those in brine containing 1, 2 or 4%. The area of greatest frequency of preferences is shown in block form in Figure 1. These comparisons have been further summarized in Figure 2 in which is shown the relative preference of beans in brines of different levels of salt and sugar concentration. Results of the study in stores show that a fairly high level of salt in the brine is preferred. Further, it appears that sugar is desired preferably with brines containing the higher levels of salt.

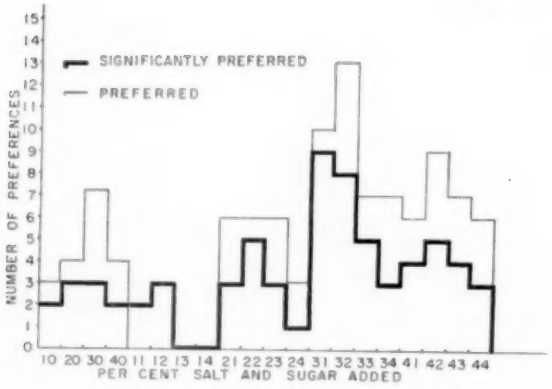
SIGNIFICANTLY PREFERRED
PREFERRED
NUMBER OF PREFERENCES
PER CENT SALT AND SUGAR ADDED
10 20 30 40 11 12 13 14 21 22 23 24 31 32 33 34 41 42 43 44

Figure 2. Frequency of preference of canned beans in brines of different levels of salt and sugar. First digit on ordinate represents per cent salt, second digit, sugar.

Brine concentrations most frequently preferred were 3% salt with 1 or 2% sugar. In nearly all combinations, the higher concentrations of sugar were not desired as frequently as the lower. Four percent sugar is excessive for the majority of consumers.

Order of presentation of the samples had a marked influence on the selection of preferred samples. [Berg *et al. (1)* have observed a bias for the first sample served for tasting.] Most consumers in our test, for any one level of salt, preferred the sugar concentration which was presented first, whether of high or low concentration. By reversing the order during the test, bias was compensated. Therefore the order of presentation of the samples had no significant influence on preference for levels of salt by the consumers in this survey.

Evaluations conducted by several consumers at home further supported the data presented in Figure 1. Although no significant difference was observed in the data from store tests between the combination of 3% salt with 1% sugar in the brine and the combination of 3% salt with 2% sugar, home tests gave slight preference for the level of 3% salt and 1% sugar. Furthermore, in home tests, the other pertinent fact was that the level of 2% salt was selected as being just as desirable as 3%, when sugar concentrations were the same. Whether the individuals at home salted their food at the table is not known, nor was their menu reported. Information from the home tests has been summarized in Table 1 along with data from a mass panel test.

Results from the panel test varied from store tests and home tests. Many authors have discussed the effect of fatigue on taste sensitivity; yet, despite the warnings that the number of samples in a given test should be limited because of fatigue, canners do employ mass panel tests indiscriminately. They perform mass panel tests not only for routine control to ensure that no disturbances have arisen, but also for establishing their concept of consumer acceptance. Results from the mass panel test show that the brine containing 2% salt and 1% sugar ranked first in preference. A plain 2% salt brine ranked second, and a 2% salt and 2% sugar brine combination ranked third. Judgments above the first five places were automatically given a numerical score of six.

Based upon results of the mass panel test, the current practice of the canner to use 1 or 2% salt brine appears to be desirable. But based on the probably more reliable duo test and home test, the recommendation to the canner would be to use a slightly higher concentration of salt, between 2 and 3%.

Chi-squared tests applied to the data from store tests for differences in selection according to sex and age of the participant were rarely significant. Supervisors noted that children about the age of 2 to 7 accompanied by their mother or by older children generally copied the ratings of the older person rather than making an independent decision. Apparently, fathers more generally than mothers permitted the child to make the selection. Whenever the supervisor observed a child to be influenced by another person, the card was marked *invalid* and was not counted in the 50 evaluations.

TABLE 1

Flavor evaluation of canned green beans in varying concentrations of salt and sugar employing mass panel test and home consumption tests. In the panel test, judgments after the first five places were scored numerically six

Sample	Mass panel test			Home tests		
	Number of judgments	Total score	Rank	Number of judgments	Remarks	Rank
10	12	71	18	3	flat	fair
20	12	47	2	6	.....	fair
30	12	65	9	4	salty	fair
40	12	68	13	3	salty	poor
11	12	70	17	3	flat	poor
12	12	67	11	5	flat	fair
13	12	67	11	6	sweet	fair
14	12	66	10	5	sweet	fair
21	12	33	1	14	good	3rd
22	12	56	3	8	good	4th
23	12	62	7	6	sweet	fair
24	12	68	13	9	sweet	fair
31	12	68	13	9	good	1st
32	12	59	4	11	fair	5th
33	12	59	4	9	salty	2nd
34	12	72	19	10	sweet	fair
41	12	72	19	18	salty	fair
42	12	68	13	5	salty	fair
43	12	62	7	9	salty	fair
44	12	60	6	4	salty	poor

SUMMARY

Canned Refugee variety green cut beans in varying levels of salt and sugar brines were presented to consumers in stores in paired samples for preference judgments. Approximately 10,000 taste evaluations were conducted in stores and augmented by some home tests during meals. A statistically significant proportion of the consumers preferred green beans in a brine containing 3% salt. Sugar in the brine was preferable only with the higher concentrations of salt.

Acknowledgment

The authors wish to acknowledge the helpful assistance of Al Schuchardt and George Hansen, Country Gardens, Inc., Coleman, Wisconsin for the use of facilities for processing the beans used in this study.

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A Chemical and Flavor Study of Off-Flavor Due to Artificial Pepper[a]

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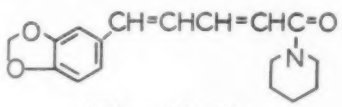
(Manuscript received June 14, 1956)

A single off-factor in a highly blended food product can upset the entire flavor, changing the character completely.

The work carried out in our laboratories on black pepper resulted from the use of an abnormally compounded pepper in the preparation of a high quality commercial product. This paper has two main objectives: (a) to describe the method we used in detecting, isolating, and characterizing the pepper compound responsible for the flavor upset in a high-quality food product—thereby showing the effectiveness of integrating flavor and chemical analyses in solving such a problem; and (b) to outline an expedient method of determining the suitability of any black pepper oleoresin for use in a good product.

Composition of black pepper oleoresin. The principal components of pepper flavor are its aromatic or odor-bearing constituents and its mouth-feeling factors, referred to as "bite". The aromatic factors are contained in the volatile oils which can be obtained from pepper oleoresin by distillation. The "bite" principle is found in its non-volatile components.

Recently most of the chemical components of pepper oil have been identified by Hasselstrom *et al. (7, 8)*. Some of these compounds are α-pinene, β-pinene, l-α-phellandrene, dl-limonene, piperonal, dihydrocarveol, β-caryophyllene, various oxygenated compounds and a piperidine complex. The chemical investigation of pepper bite has been the subject of a major body of research since the first isolation of crystalline piperine in 1820 *(13)*. It is generally believed that the active principle of black pepper consists of a mixture of piperine and a very pungent resin—chavicine, a steriosomer of piperine.



1-Piperoylpiperidine
(piperine)

An excellent review of the elucidation of the structure of these compounds has been made by Newman *(11)*. Investigations of the other components of the non-volatile pungent fraction of black pepper and of the relative contribution of piperine and chavicine to pepper "bite" are currently in progress *(16)*. A comprehensive review of synthetic bite compounds with melting or boiling points, degree of pungency and taste, and literature references to their preparation has been published by Newman *(12)*.

Since piperine is universally accepted as the predominant pungent principle in black pepper, piperine content is generally used as a basis for judgment of pepper quality. Almost identical spectrophotometric methods of piperine assay have recently been published by the research laboratories of the William J. Stange Co. *(16)* and of the Kraft Foods Co. *(5)*. These methods are based upon the ultraviolet absorption spectrum of piperine and are therefore superior to the Kjeldahl *(14)* determination of total nitrogen in which piperine could not be distinguished from other nitrogenous materials present either as natural components or as intentional adulterants.

EXPERIMENTAL

The present investigation was initiated when a normally high-quality food product was found to have developed unusual and somewhat disturbing flavor characteristics. This change was defined by an experienced flavor panel using the Flavor Profile method *(1, 3)*. The intentionally high blends of aroma and flavor in the normal product were upset, and a foreign character note described as "woody-raisin" dominated the profiles of both the aroma and the flavor.

Although it was possible that the off-flavor was the result of some reaction occurring during the preparation of the product, careful flavor analysis of each ingredient that had gone into the product pointed to the black pepper oleoresin. Subsequently, the product was prepared in the laboratory with various known quantities of the suspect oleoresin and with duplicate quantities of an authentic oleoresin. Flavor panel findings showed that the black pepper oleoresin was undoubtedly the sole source of the foreign note in the final product.

The next step in the investigation was to find out the nature of the abnormality of the offensive black pepper oleoresin. Three major physicochemical approaches were employed, each involving parallel treatment of the abnormal sample and an authentic sample of black pepper oleoresin: (a) spectrographic determination of piperine content; (b) chromatographic separation; (c) fractional distillation of volatile oils and purification of nonvolatile residue.

Throughout the physicochemical investigation, the flavor panel served to evaluate the isolates. For aroma, the panel analyzed the isolates suspended in odorless mineral oil. For flavor, the panel tasted specially prepared samples of the final product from which pepper had been omitted and in which were

[a] Presented at Sixteenth Annual Meeting of the Institute of Food Technologists, St. Louis, Missouri, June 13, 1956.

incorporated known amounts of the isolates to be evaluated. In this manner the direction of the chemical investigation was guided by the findings of the panel, and unnecessary chemical work was avoided.

Methods. *Spectrophotometric Determination of Piperine.* The method of Fagan, Kolen, and Hussong *(5)* was used to determine piperine in the oleoresins of black pepper. Piperine was isolated from oleoresin of black pepper and purified to constant melting point (m.p. 132-133°) by recrystallization from absolute ethanol.

All spectrophotometric measurements were made on a Beckman Model DU Spectrophotometer with ultraviolet attachment. One-centimeter matched silica cells were used.

Chromatographic Separation of Authentic and Abnormal Oleoresins. Each oleoresin (0.250 g.) was added to a column (1 x 30 cm.) prepared from a slurry of 8 g. of untreated Merck "Aluminum Oxide Suitable for Chromatographic Use" in Skellysolve B. The alumina was Brockmann grade V activity *(2)* and had pH 9-10. The columns were run concurrently and were eluted with two 5 ml.-portions of each of the following solvents: Skellysolve B, skellysolve-benzene (4:1), skellysolve-benzene (3:2), skellysolve-benzene (2:3), skellysolve-benzene (1:4), benzene, benzene-ethyl ether (4:1), benzene-ethyl ether (3:2), benzene-ethyl ether (2:3), benzene-ethyl ether (1:4), ethyl ether, ethyl ether-ethanol (4:1), ethyl ether-ethanol (3:2), ethyl ether-ethanol (2:3), ethyl ether-ethanol (1:4), ethanol, 80% aqueous ethanol, 60% ethanol, 40% ethanol, 20% ethanol and water. General examination of the physical properties and odor of each of the resulting 42 fractions was carried out after removal of solvent under reduced pressure. Fractions 12-20 from the authentic oleoresin were combined and recrystallized from hot absolute ethanol. Piperine (m.p. 132-133°) was obtained as pale yellow crystals; λmax 344 mμ. Fractions 12-17 from the abnormal oleoresin were combined. Purification by sublimation under reduced pressure yielded a white crystalline compound, m.p. 122-123°; λmax 275 mμ.

Separation of Volatile Oils. A. Abnormal Oleoresin. A suspension of 11.4 g. of abnormal oleoresin in 300 ml. of water was distilled in the normal manner in a Clevenger still *(10)*. The distillate thus obtained was extracted with ether and the ether extract containing the volatile oils was dried over anhydrous sodium sulfate. Removal of solvent under reduced pressure yielded a clear liquid, 1.4729 g. (12.8%), $n_D^{25°}$ 1.4948. This liquid exhibited the sought for off-flavor. Vapor chromatograms were obtained by means of a Perkin-Elmer Vapor Fractometer, Model 154. The column temperature used was 150° C.

Distillation of the volatile oils in a semimicro column *(6)* yielded the following fractions: 1) b.p. 75-79° (1 mm.); 0.3334 g.; $n_D^{24°}$ 1.4934. 2) b.p. 79-83° (1 mm.); 0.5912 g.; $n_D^{24°}$ 1.4962. Redistillation of the second fraction yielded an analytically pure sample $n_D^{24°}$ 1.4964; $[\alpha]_D^{25°}$ — 12.5°; sp. gr. 25°/4° 0.8810. This liquid when incorporated in the original product at a concentration of 2 p.p.m. (0.0002%) exhibited the typical unpleasant flavor and aroma first noted.

Analysis. Calculated for $C_{15}H_{24}$: C, 88.16; H, 11.84; mol. wt. 204. Found: C, 88.19; H, 12.01; mol. wt. 217 (Rast method in camphor). Sodium fusion disclosed no other elements.

The infrared spectrum of the off-flavor liquid was typical of that of terpenes in that the presence of a terminal isopropyl group and an exocyclic methylene group was indicated.

B. Authentic Oleoresin. The volatile oils were removed in the manner described above from 30 g. of authentic oleoresin. A colorless liquid which exhibited no off-flavor or aroma was obtained in 2.7% yield: 0.8291 g.; n_D^{25} 1.4890. Vapor chromatograms were obtained at a column temperature of 150° C. Distillation in a semimicro column *(6)* yielded the following fractions: 1) b.p. 62-75° (1 mm.); 0.0637 g.; $n_D^{24°}$ 1.4938. 2) b.p. 75-76° (1 mm.); 0.2030 g.; $n_D^{25°}$ 1.4942; $[\alpha]_D^{25°}$ — 12.6°; sp. gr. 25°/4° 0.8930. Neither fraction exhibited off-flavor.

Investigation of Nonvolatile Portions. A. Abnormal Oleoresin. The aqueous suspension remaining after distillation of the volatile oils contained an insoluble resinous material and a white crystalline solid. The suspension was extracted with ether, the yellow ether extract dried, concentrated under reduced pressure and the residue was sublimed at 60-70° (1-2 mm.). A white crystalline sublimate was obtained in 25% yield. Resublimation yielded an analytically pure sample, m.p. 122-123°, which had no odor but provided a sharp pepper-bite.

Analysis. Calculated for $C_{17}H_{21}NO$: C, 78.10; H, 7.96; N, 6.51; mol. wt. 215. Found: C, 78.18; H, 8.19; N, 6.56; mol. wt. 242 (Rast method in camphor). Sodium fusion disclosed no other elements. λmax 275 mμ. (See Figure 2).

This compound was proved to be 1-cinnamoyl piperidine by comparison with an authentic sample[b] of this substance. The

B. Authentic Oleoresin. The aqueous suspension remaining after removal of the volatile oils contained an insoluble resinous layer. There was no evidence of any compound similar to 1-cinnamoyl piperidine described above. The dark resinous layer was separate and treated with boiling ethanol. Crystalline piperine (m.p. 132-133°) was obtained. No attempt to further investigate this fraction was made.

RESULTS

As depicted in Table 1 spectrographic determinations showed a significant lack of piperine in the abnormal oleoresin. It contained less than half the amount of piperine found in the authentic oleoresin. Evidence that the off-flavor oleoresin contained an abnormal constituent or adulterant was provided by its ultraviolet spectrum. It showed, in addition to the usual piperine maximum at 344 mμ, an additional strong peak at 275 mμ. (See Figure 1.) This finding suggested that

TABLE 1

Comparison of general characteristics of authentic and abnormal pepper oleoresins

	Authentic Oleoresin	Abnormal Oleoresin
Aroma	Typical pepper	Woody in addition to pepper
Flavor	Typical pepper	Woody-raisin
Color	Yellow	Tan to pale yellow
pH (of aqueous suspension of pepper dispersion)	7.9	7.3
Piperine content (%) (5)	46.4	19.0
Ultraviolet spectrum (λmax in chloroform)	344 mμ	344 mμ 275 mμ

[b] Kindly provided by Dr. L. C. King, Northwestern University.

melting point, mixed melting point and infrared spectrum of both were identical.

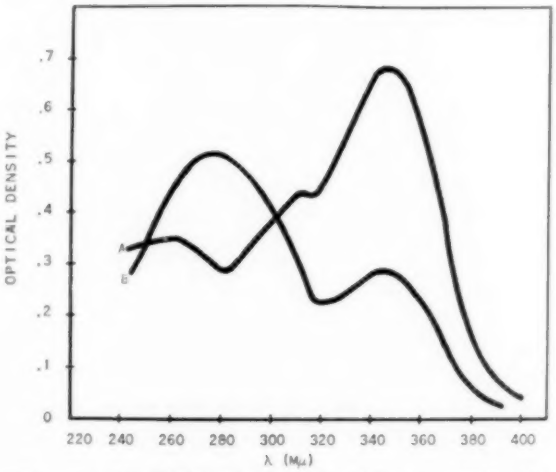


Figure 1. Ultraviolet spectrum of authentic oleoresin (A) and abnormal oleoresin (B) in chloroform.

the compound responsible for the abnormal spectrum was probably a nitrogeneous substance added to mask the lack of a normal piperine content. Since the Kjeldahl total nitrogen determination *(14)* of piperine could not have provided this information the value of the spectrophotometric piperine determinations is well illustrated.

Initial chemical evidence concerning the apparent abnormal composition of the adulterated oleoresin was provided by chromatographic separation of the oleoresins on alumina. The use of column chromatography in problems involving the separation of complex flavorful materials is often very helpful since in favorable cases it provides, in addition to chemical separation, a general odor and flavor spectrum of the material. Chromatographic separation of the authentic and abnormal pepper oleoresins was followed by odor and flavor evaluation and qualitative chemical examination of the resulting fractions. The results summarized in Table 2 showed that the oleoresins were apparently

TABLE 2

Chromatographic separation of oleoresins

Fraction No.	Eluant	Authentic Oleoresin	Abnormal Oleoresin
1	Skellysolve B		
2	Skellysolve B	Colorless liquid	Colorless liquid
3	Skellysolve-benzene (4:1)	Colorless liquid	.....
4	Skellysolve-benzene (4:1)	Colorless liquid	.....
5	Skellysolve-benzene (3:2)	Colorless liquid	.....
6	Skellysolve-benzene (3:2)	Yellow liquid	.....
7	Skellysolve-benzene (2:3)	Yellow liquid	Colorless liquid
8	Skellysolve-benzene (2:3)	Yellow liquid	Colorless liquid
9	Skellysolve-benzene (1:4)	Yellow liquid	Colorless liquid
10	Skellysolve-benzene (1:4)	Yellow liquid	Colorless liquid
11	Benzene	Yellow liquid	Colorless liquid
12	Benzene	Yellow solid	White crystals
13	Benzene-ethyl ether (4:1)	Yellow solid	White crystals
14	Benzene-ethyl ether (4:1)	Yellow solid	White crystals
15	Benzene-ethyl ether (3:2)	Yellow solid	White crystals
16	Benzene-ethyl ether (3:2)	Yellow solid	White crystals
17	Benzene-ethyl ether (2:3)	Yellow solid	White crystals
18	Benzene-ethyl ether (2:3)	Yellow solid	Yellow liquid
19	Benzene-ethyl ether (1:4)	Yellow solid	Yellow liquid
20	Benzene-ethyl ether (1:4)	Yellow solid	Yellow liquid
21	Ethyl ether	.....	.....
22	Ethyl ether	.....	.....
23	Ethyl ether-ethanol (4:1)	.....	.....
24	Ethyl ether-ethanol (4:1)	Yellow liquid	Yellow liquid
26	Ethyl ether-ethanol (3:2)	Yellow liquid	Yellow liquid
25	Ethyl ether-ethanol (3:2)	.....	.....
27	Ethyl ether-ethanol (2:3)	.....	.....
28	Ethyl ether-ethanol (2:3)	.....	.....
29	Ethyl ether-ethanol (1:4)	.....	.....
30	Ethyl ether-ethanol (1:4)	.....	.....
31	Absolute ethanol	.....	.....
32	Absolute ethanol	.....	.....
33	80% ethanol	.....	.....
34	80% ethanol	Yellow liquid	Yellow liquid
35	60% ethanol	Yellow solid	Yellow solid
36	60% ethanol	Yellow solid	Yellow solid
37	40% ethanol	Yellow solid	Yellow solid
38	40% ethanol	Yellow solid	Yellow solid
39	20% ethanol	White solid	White solid
40	20% ethanol	White solid	White solid
41	Water	White solid	White solid
42	Water	White solid	White solid

Fractions 12-20 from authentic oleoresin contained piperine.
Fractions 12-17 from abnormal oleoresin contained 1-cinnamoyl piperidine.
Fractions 18-20 are believed to have contained crude piperine.

similar with the exception that the abnormal oleoresin lacked piperine but contained a white crystalline solid which was not present in the authentic oleoresin. This compound when evaluated for odor and flavor provided pepper-bite but had none of the aromatic odor common to pepper. As shown in Figure 2, its ultraviolet spectrum showed a strong peak at 275 mμ. This compound was undoubtedly the cause of the abnormal spectrum noted in the spectrophotometric piperine determination of abnormal oleoresin. Examination of all the chromatographic fractions failed to turn up any which exhibited the characteristic unpleasant "woody-raisin" off-flavor, the isolation of which was the goal of the investigation.

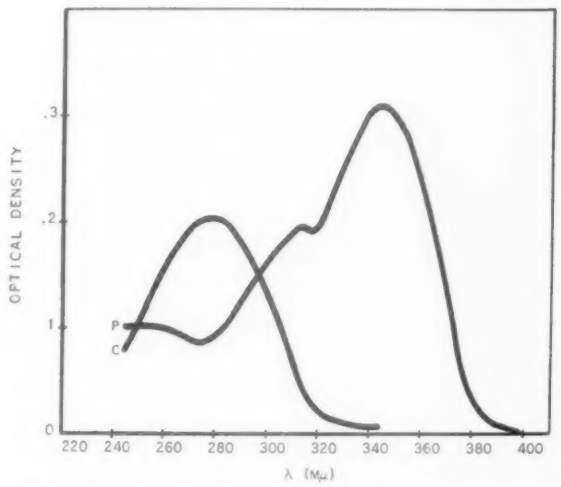


Figure 2. Ultraviolet spectrum of piperine (P) and abnormal pepper-bite compound (1-cinnamoyl piperidine [C]).

Real progress toward isolation of the substance responsible for off-flavor was accomplished by routine removal of the volatile oils by distillation of the oleoresins *(10)*. The physical properties of the oils thus obtained (See Table 3) varied slightly. The yield of

TABLE 3

Physical properties of isolates from authentic and abnormal pepper oleoresins

	Authentic Oleoresin	Abnormal Oleoresin
Volatile Oils		
Yield (%)	2.3	12
Refractive index ($n_D^{24°}$)	1.4890	1.4948
Flavor	Good	Woody-raisin
Distillation of Volatile Oils		
Fraction 1		
Refractive index ($n_D^{24°}$)	1.4938	1.4934
Fraction 2		
Refractive index ($n_D^{24°}$)	1.4942	1.4964
Specific rotation $[\alpha]_D^{25°}$	−12.6°	−12.5°
Specific gravity (25°/4°)	.8930	.8810
Flavor	Good	Woody-raisin
Nonvolatile Fraction		
Piperine content (%)	46.4	19.0
1-Cinnamoyl piperidine (%)	.....	25

oil from the abnormal oleoresin was much larger than from the standard. Flavor evaluation of these oils, however, immediately revealed the presence of the off-flavor in the sample derived from abnormal oleoresin. Physical evidence that the oils differed fundamentally was provided by vapor phase chromatography. In Figure 3 the chromatogram of the volatile oils from the abnormal oleoresin is completely blank while the corresponding chromatogram of oils from the authentic oleoresin

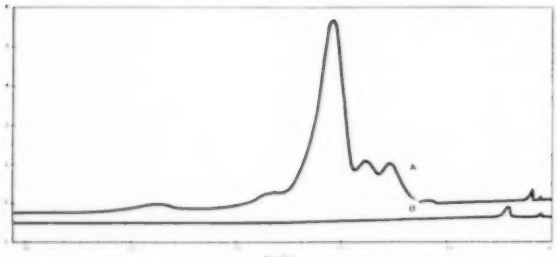


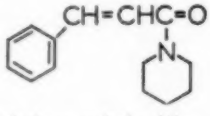
Figure 3. Vapor chromatogram of volatile oils from authentic oleoresin (A) and abnormal oleoresin (B).

shows the presence of at least three volatile components. Although this indicated that the component producing off-flavor was too low in volatility to be detected by vapor phase chromatography at 150° C. it illustrated the absence of several apparently normal volatile components in the abnormal oleoresin.

Isolation of the component of the abnormal pepper oil which was responsible for its unpleasant flavor was accomplished by vacuum fractional distillation of the oil. A colorless liquid fraction was obtained (b.p. 79-80 (1 mm.); $n_D^{24°}$ 1.4964; $[\alpha]_D^{25°}$ — 12.5°) which when incorporated at a concentration of 2 p.p.m. (0.0002%) in the original product exhibited the typical unpleasant flavor and aroma first noted. Elemental analysis showed it to be a hydrocarbon of the composition $C_{15}H_{24}$. Its infrared spectrum indicated a probable mixture and the presence of such typical terpene groups as an isopropyl and an exocyclic methylene group. It was thus concluded that the liquid which had been the cause of unpleasant flavor was a mixture of isomeric sesquiterpene hydrocarbons. Further identification of the liquid was not attempted.

Fractional distillation of the volatile oils of the authentic pepper oleoresin yielded a liquid quite similar in physical properties (b.p. 75 (1 mm.); $n_D^{25°}$ 1.4942; $[\alpha]_D^{25°}$ — 12.6) but which did not exhibit the unpleasant off-flavor. No attempt was made to identify this material. It was undoubtedly also a terpene hydrocarbon mixture.

During the removal of the volatile oils from the abnormal oleoresin, quantities of the unknown white crystalline pepper-bite compound were obtained. Purification of this substance by sublimation resulted in the isolation of a pure compound (m.p. 122-123°) having the composition $C_{14}H_{17}NO$. This compound was identified as 1-cinnamoyl piperidine by comparison with an authentic sample (see footnote [b]) of this substance.



1-cinnamoyl piperidine

The melting points, mixed melting point and infrared spectrum of each were identical. 1-Cinnamoyl piperidine is known *(9, 15)* to be a pepper-bite compound and can be easily prepared synthetically *(4)*.

SUMMARY AND CONCLUSIONS

The suitability of a black pepper oleoresin for use in a food product can only be determined by flavor analysis. If the pepper is found unsuitable the source of its abnormal flavor can be traced by the coordinated use of flavor evaluation and chemical investigation. The spectrophotometric determination *(5, 16)* of piperine is an excellent method for evaluating the composition of the oleoresin. This method in conjunction with flavor evaluation of the oleoresin should reveal the presence of a potential off-flavor producing pepper "bite" substance.

Evaluation of the suitability of the aromatic volatile oils of pepper is more complicated since it requires their separation from the oleoresin before their real contribution to flavor can be judged. Judgment on the volatile oil fractions must be based on flavor evaluation and on the general physical properties and yield of the oils. Due to the general over-all similarity of the terpenes in spite of possessing many detailed differences, a general quick method of evaluating their chemical identity is not possible. Flavor evaluation of the oils must therefore be depended upon more fully than in the case of the nonvolatile pungent principle.

On the basis of this investigation it was concluded that the abnormal black pepper oleoresin contained chemical constituents normal to black pepper plus abnormal constituents. Abnormal chemical compounds were found both in the aroma-bearing volatile oil and the nonvolatile pungent principle.

A sesquiterpene hydrocarbon fraction isolated from the volatile portion of the pepper oleoresin was the source of off-flavor detected in a commercial product processed with the pepper oleoresin. This off-flavor could be reproduced by adding 0.0002% of the fraction to the commercial product specially prepared to contain all ingredients except pepper.

The nonvolatile portion of the oleoresin contained considerably less than the normal quantity of piperine, which is a pungency principle. In addition, the nonvolatile portion contained 1-cinnamoyl piperidine, a synthetic pepper bite compound not known to be a constituent of natural black pepper oleoresin. It is, therefore, concluded that the black pepper oleoresin was adulterated.

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The Breakdown of Strawberry Anthocyanin Pigment

(Manuscript received April 9, 1956)

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The breakdown of anthocyanins in natural and model systems has been studied previously by several investigators. These studies were generally conducted in the presence of hydrogen peroxide or ascorbic acid. Sondheimer and Kertesz *(16)* presented a hypothesis for the breakdown of anthocyanins by the addition of hydrogen peroxide to pelargonidin-3-monoglucoside as occurring through the carbonium ion. This is in accord with the conclusions of Dilthey *et al. (2, 3)*, who studied the oxidation of pyrenium salts by hydrogen peroxide.

Karrer and De Meuron *(5)* demonstrated the formation (65% yield) of malvone from malvidin chloride in the presence of hydrogen peroxide. On the basis of the proposed structure of malvone, he assumed position 2 of the flavylium salt to be the site of hydrogen peroxide addition. Leffler *(6)* noted that hydroperoxides of anthocyanins gave rearranged products due to the cleavage of a neighboring carbon to carbon bond.

The importance of peroxides in the degradation of anthocyanin in natural products, as distinct from model systems, has not yet been established, although it is known that hydrogen peroxide is produced by the reaction of ascorbic acid and oxygen in the presence of cupric ion *(12)*. Beattie *et al. (1)* suggested that ascorbic acid might play a role in the deterioration of pigments in fruit juices. Pederson *et al. (9)* observed parallel losses of anthocyanin and ascorbic acid in juices, and suggested a possible interaction between these compounds. Pratt *et al. (10)* and Meschter *(8)* found that ascorbic acid and anthocyanin pigments interact, with the subsequent destruction of the color. Livingston *et al. (7)* studied several factors including ascorbic acid which affect the discoloration of pectin gels.

Sondheimer and Kertesz *(17)* demonstrated that ascorbic acid induces the destruction of anthocyanin pigments in strawberry juice, both aerobically and anaerobically. They noted an increase in the rate of destruction in the presence of ascorbic acid if cupric ion were present. Meschter *(8)* observed a marked difference in the effects of ascorbic acid and dehydro-ascorbic acids on pigment loss in buffered solutions.

Huang *(4)* determined the mechanism of decoloration of anthocyanin by fungal enzymes. He regarded it as a two-step process, involving enzymatic hydrolysis of the anthocyanin and a decoloration of the liberated aglucone by transformation into one of several possible pseudobase modifications *(11)*. There was an increase of decolorizing activity with increase in pH in the range 3.0 to 4.5. Few data have been accumulated on the breakdown of anthocyanins in the absence of oxidizing agents. The nature of the breakdown products and the reactions causing the breakdown are not known.

The present study is concerned with the effect of pH on the rate of pelargonidin-3-glucoside destruction in pure pigment solutions and strawberry juice. Spectral characteristics of the pigment breakdown products have also been studied.

EXPERIMENTAL

I. RATE STUDIES

(a) *Pure pigment solutions:* Pure pigment solutions of pelargonidin-3-glucoside were obtained from strawberries (Shasta variety) by extraction with n-butanol. Crude pigment was precipitated by addition of diethyl ether. The precipitate was then dissolved in water, isolated as the crystalline picrate, and then converted to the chloride. Before use, the chloride was re-crystallized from a solution of ethyl alcohol-5% hydrochloric acid *(14)*.

A series of 0.10 molar citrate buffer solutions with pH values of 1.25, 2.0, 2.7, 3.25, 3.40, 3.85, and 4.50 was prepared. To 50 ml. of each, 2 ml. of an aqueous solution of pigment containing 52 mg. per 100 ml. were added to give a final pigment concentration of 4.27×10^{-5} moles per liter. The buffered solutions were introduced into 100 ml. tubes through which oxygen or nitrogen (after passing through pyrogallol) could be bubbled via a side arm. To prevent loss of water, the tubes were equipped with reflux condensers. The pigment solutions were maintained at 45° C. in a constant temperature water bath over a period of 10 days in the oxygen samples and 32 days in the nitrogen samples.

(b) *Strawberry juice:* A water extract of Shasta strawberries was prepared by macerating frozen berries in a Waring blender. A clear solution was obtained by filtration through a layer of Hyflo Super Cel. The extract was divided into 3 portions and each adjusted to a different pH value with concentrated HCl or concentrated NaOH. The juice was introduced into tubes as in (a). Oxygen was bubbled through one set of tubes and nitrogen through another. The samples were heated for 5 days at 45° C. ± 0.5 in a constant temperature water bath.

(c) *Pigment determination:* The pure pigment solution and the strawberry juice were periodically sampled. Pigment concentration was determined in both cases by the method of Sondheimer and Kertesz *(15)*. A simpler method applicable only to the pure pigment solution gave identical results. It is discussed later.

II. STUDIES OF MECHANISM

Pure pigment was dissolved in 0.02 M citrate buffer at pH 3.4 and heated at 55° C. under oxygen for 10 days in the apparatus described above. Samples were removed every 2 days after correction of minor volume losses due to evaporation. During the heating, a red-brown precipitate formed. To insure homogeneity, before a sample was removed, the solution was stirred vigorously and aliquots taken rapidly. Samples thus obtained were cooled and filtered on a sintered glass filter. The absorption spectrum of the filtrate was measured in 0.1 *M* citrate buffer at pH 3.4. The material remaining on the sinter after filtering was washed 3 times with water, then with ether, and dissolved in absolute ethanol-0.001 *M* HCl. The absorption spectrum was then measured.

(a) *Chromatography:* Samples were chromatographed on paper using n-butanol-2 *N* HCl* as solvent.

To obtain well defined spots on chromatograms, it was necessary to remove the salt. This was accomplished by extracting the solution with n-butanol. The n-butanol solution was evaporated to a small volume and streaked across Whatman No. 1 filter papers, 18 x 22 in. After removal of the solvent, strips containing the isolated materials were cut out and eluted with a mixture of water, acetic acid and hydrochloric acid (30:10:3). The solvent was removed in vacuum and the residues dissolved in ethyl alcohol (0.001 *M* HCl). The spectrum of the red-brown material was determined after corrections had been made for absorption of contaminants eluted from the filter paper.

(b) *Degradation of the aglucone:* The aglucone was prepared by boiling the glucoside in 5 *N* HCl for 3 minutes and collecting the resulting crystalline precipitate which formed on cooling. The aglucone was washed with cold 1% hydrochloric acid, then with ether and air-dried. It was recrystallized from hot dilute hydrochloric acid. The absorption spectrum in ethanol containing 0.001 *M* HCl was identical with that given by Sondheimer and Kertesz *(14)*.

The aglucone was dissolved in 2 ml. 0.1 *M* HCl to give a saturated solution, 50 ml. of 0.1 *M* citrate buffer at pH 3.4 were added and the solution held at room temperature until completely decolorized.

(c) *Insoluble pigment breakdown product in strawberry juice:* Free-run strawberry juice was prepared from frozen Shasta strawberries by macerating in a blender, squeezing through 4 layers of cheesecloth and filtering, using Hyflo Super Cel as filter aid. The juice was heated under reflux in air at 55° C. Samples were removed periodically, filtered on a sintered glass filter, and the precipitate washed thoroughly with cold 0.1 *M* HCl, water, then ether. It was then dried.

RESULTS

Rate studies. On heating, the buffered pigment solutions became brown as the pigment disappeared. Concurrently a red-brown precipitate formed in oxygen. Aliquots of each solution were removed periodically and the optical density at 440, 500, and 700 mμ was determined. The value at 700 mμ (a measure of the turbidity of the solution) was subtracted from that at 440 and 500 mμ. The optical density of the pigment at 500 mμ was calculated from the following equations, which take into account the absorbance of pigment breakdown products:

$$D^{500} = D_B{}^{500} + D_P{}^{500}$$
$$D^{440} = 0.48\, D_P{}^{500} + 2.3\, D_B{}^{500}$$

where D_P is the optical density of the pigment and D_B is that of the brown breakdown products. The value 0.48 is the ratio of absorption of the pigment at 500 mμ to that at 440 mμ at pH 1.25 and 2.70. However, at pH 3.25, 3.85, and 4.50 the ratios are 0.49, 0.57, and 0.69, respectively. The ratio of absorption at 440 to that at 500 mμ of the breakdown products was determined from the absorption spectrum of the brown soluble material which had been separated and characterized by paper chromatography (Section II). The formation of soluble breakdown products (which is expressed as the non-anthocyanin pigment absorption at 440 mμ) was also determined (Table 1).

TABLE 1
Change in optical density 440 mμ. Corrected for pigment absorption

Time in hours	Optical density pH				
	1.25	2.70	3.25	3.85	4.50
0	0	0	0	0	0
96	0	.005	.012	.030	.026
124	0	.018	.030	.030	.035
172	0	.028	.041	.036	.036
220	0	.034	.035	.039	.034

The change in pigment concentration was calculated by solving the simultaneous equations for $D_P{}^{500}$. The specific rate constants, k, at various pH values for the first order reaction by which the pigment is destroyed were derived from plots of the values thus determined (Tables 2, 2a).

Sondheimer *(13)* determined the relation between spectral changes and pH of pelargonidin-3-monoglucoside. Evidence was presented for the hypothesis that there is an equilibrium between hydronium ions and the anthocyanin in the forms of a red cation, R^+, and a

* This solvent was made by equilibrating equal volumes of n-butanol and 2 *N* hydrochloric acid. The upper layer was used as the solvent.

TABLE 2
Changes in optical density at 500 mμ of buffered pigment solutions as a function of pH, corrected for non-anthocyanin absorption

Atmosphere	pH	Optical density 500 mμ							
		Time in hours							
		0	96	124	172	220			
Oxygen	1.25	1.025	1.00	0.990	0.970	0.960			
	2.70	0.600	0.496	0.470	0.431	0.407			
	3.25	0.309	0.247	0.219	0.205	0.167			
	3.85	0.130	0.094	0.0822	0.0695	0.067			
	4.50	0.080	0.0537	0.0499	0.0403	0.0361			
		Time in hours							
Atmosphere	pH	0	24	48	96	168	312	480	768
Nitrogen	2.10	2.10	2.09	2.04	2.01	1.81	1.77	1.70	1.53
	3.40	0.630	0.593	0.594	0.577	0.537	0.489	0.443	0.319
	4.50	0.176	0.165	0.165	0.160	0.140	0.133	0.116	0.091

TABLE 2a

Specific rate constants for anthocyanin destruction in citrate buffered pure pigment solutions and in strawberry juice at various pH values at 45° C.

Solution	Atmosphere	pH	R^+%	k (hours^{-1})
In citrate buffered pure pigment solutions	oxygen	1.25	98	2.8×10^{-4}
		2.70	64	19.6×10^{-4}
		3.25	35.5	27.5×10^{-4}
		3.85	14	36.1×10^{-4}
		4.50	3	38.6×10^{-4}
In citrate buffered pure pigment solutions	nitrogen	2.0	89.5	5.77×10^{-4}
		3.4	28.5	6.72×10^{-4}
		4.5	3	7.13×10^{-4}
In strawberry juice	oxygen	3.05	46	357×10^{-4}
		3.55	23	650×10^{-4}
		4.30	5	920×10^{-4}
In strawberry juice	nitrogen	3.05	46	51.0×10^{-4}
		3.55	23	59.7×10^{-4}
		4.30	5	74.5×10^{-4}

colorless pseudobase, ROH. The equilibrium was formulated thus:

$$R^+ + 2\,H_2O \rightleftarrows ROH + H_3O^+$$

The observed pK at 25° C. for the reaction was 2.98 ± 0.06 *(13)*, as calculated from optical density data at various levels. The pK was constant for the pH range in which the R^+ concentration varied between 98.4 and 10.4% of the pigment. Sondheimer also showed that the pK was independent of the anthocyanin concentration and that the equilibrium could be approached from either side.

We determined the pK for this equilibrium at 45° C. and found it identical with that reported at 25° C. *(13)*. When the percentage of pigment in the R^+ form corresponding to each pH value is plotted against the specific rate constant obtained in oxygen and nitrogen at the same pH as given in Table 2, two straight lines (Figure 1) are obtained, differing markedly in slope.

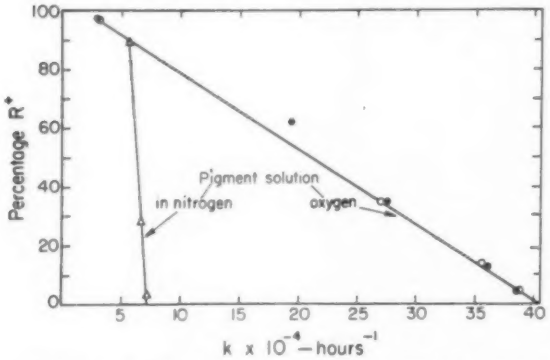

Figure 1. Effect of pH on rate of anthocyanin destruction in 0.1 M citrate buffer heated at 45° C. in oxygen and in nitrogen.

Alternatively, the percentage of pigment existing in the R^+ form is a function of pH. Since the rate constant is proportional to the percentage of R^+, a more direct method of arriving at the rate constant may be used. The specific rate constant (over a limited range of pH) is rectilinearly related to $(pH)^2$. Thus it is possible to determine the rate of color loss directly as a function of pH.

The rate of anthocyanin destruction in excess of oxygen is pH-dependent and appears to be directly proportional to the amount of the pigment which exists in the form of the pseudobase, and inversely proportional to the pigment in the cation or colored form.[b] However, in the case of pigment degradation in nitrogen, the rate is virtually independent of the pH.

Figure 2 shows the relation between percentage R^+ and rate constant (k) for strawberry juice in oxygen and nitrogen derived from data in Table 3. As in the

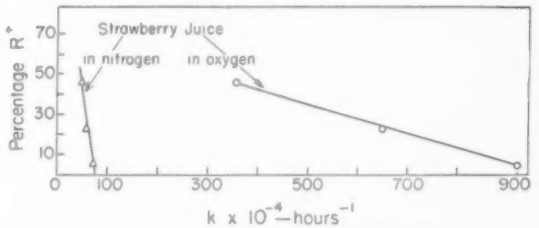

Figure 2. Effect of pH on rate of anthocyanin destruction in strawberry juice heated at 45° C. in oxygen and in nitrogen.

case of pure pigment solution, the rate of pigment destruction is pH-dependent in oxygen but not in nitrogen.

Rate of pigment loss in strawberry juice is more rapid than in pure solution at the same pH both in oxygen and in nitrogen. However, the ratios of $\triangle R^+/\triangle k$ in nitrogen versus oxygen are essentially the same for the pure solution and the strawberry juice, as shown in Table 3a.

TABLE 3

Anthocyanin concentration changes in strawberry juice

Atmosphere	pH	Time in hours				
		0	19	25	44	
Oxygen	3.05	4.06	2.335	1.825	0.748	
	3.55	4.06	1.351	0.837	0.170	
	4.30	4.06	0.879	0.409	0.080	
	pH	Time in hours				
		0	18	42	90	114
Nitrogen	3.05	4.06	3.674	3.426	2.546	2.222
	3.55	4.06	3.591	3.049	2.365	2.118
	4.30	4.06	3.365	2.700	2.023	1.763

TABLE 3a

Relation between pH and rate of anthocyanin destruction in citrate buffered pure pigment solution and in strawberry juice

Solution	Atmosphere	Change in pH (R^+) with change in rate (k) (slope $\triangle R^+/\triangle k$)	Ratio of slopes nitrogen/oxygen
Pure pigment	oxygen	2.6×10^4	24.5
	nitrogen	63.6×10^4	
Strawberry juice	oxygen	0.0746×10^4	23.4
	nitrogen	1.745×10^4	

STUDIES ON MECHANISM

(a) Absorption spectra changes

1. *Oxygen.* Absorption spectra of the filtered solutions heated at 55° C. in oxygen are shown in Figure 3. The ratio of the absorption at 440 to that at 500 mμ in-

[b] Other interpretations of the data are possible, but less plausible, and not readily susceptible to experimental proof.

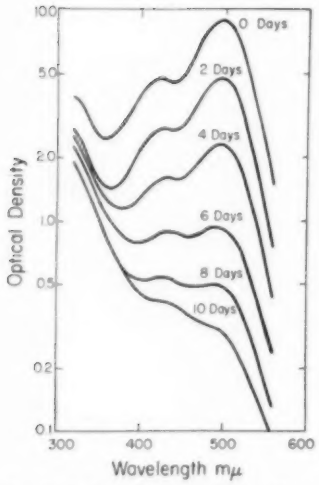

Figure 3. Spectral changes of filtered anthocyanin pigment solutions at pH 3.4 heated for 10 days at 55° C.

creases with time, approaching 2.3 as the pigment is completely destroyed. The absolute absorption at 500 mμ also decreased with time. Absorption at 700 mμ as a measure of turbidity is given in Table 4.

TABLE 4
Absorption changes in pigment solutions in oxygen at 700 mμ at pH 3.4

Time in days	0	2	4	6	8
Optical density	0	.052	.052	.065	.078

The absorption spectrum of the insoluble material, isolated by filtration, in absolute ethanol containing 0.001 *M* HCl is shown in Figure 4. Upon heating in buffer this material changes from red to brown. This change may be noted in Figure 4, which shows the progressive decrease in absorption at 520 mμ and the concurrent increase in the ratio of absorption at 450 to 520 mμ. The change is also characterized by the shift of the absorption maximum from 520 to lower wave lengths and a shift of minimum from 380 mμ to higher wave lengths.

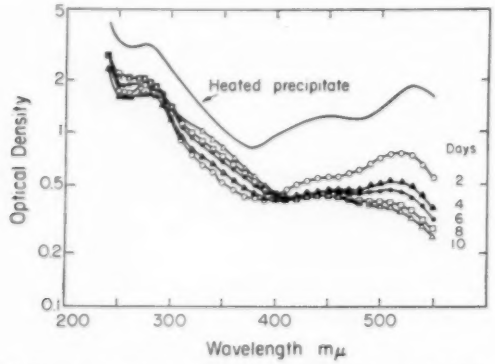

Figure 4. Spectral changes of red-brown precipitate obtained from heating pure pigment solution at 45° C. Upper curve in spectrum of precipitate heated in 95% ethanol (5% HCl). In ethanol-HCl (0.001 M) solvent.

2. *Nitrogen.* The absorption spectra of the solutions heated under nitrogen were similar to those shown in Figure 3.

The turbidity values in Table 4 indicate a relation between pigment loss and turbidity formation in oxygen. At equivalent pigment losses in nitrogen no measurable turbidity formed. However, at the conclusion of the experiment (described in Section 1, a) a slight film was observed adhering to the glass of the reaction tube. This was washed with dilute HCl, water and then dried. The deposit was dissolved in absolute ethanol containing 0.001 *M* HCl and the spectrum was determined. It was the same as that shown in Figure 4 (at 2 days).

(b) Chromatography

In preliminary chromatograms of the reaction mixture heated at 55° C. nioxygen at pH 3.4 several distinct spots appeared. The anthocyanin pigment in n-butanol-2 *N* HCl had an R_f of 0.52. The red-brown breakdown product which precipitated from the buffer solution had an R_f of 0.75. A brown material also formed a distinct spot on the chromatogram and moved in this solvent close to the solvent front. A yellow material with an R_f only slightly greater than that of the red-brown compound was observed. When the sample was given a preliminary extraction with ethyl acetate, this yellow material was no longer observed on chromatograms. The absorption spectra of the ethyl acetate extracts were determined. In all cases, a peak occurred at 253 mμ. Extracts were combined and evaporated in vacuo and then dissolved in ethyl ether. The ethyl ether solution was washed with water and the absorption spectra after evaporation of the ether was again determined in absolute ethyl alcohol. The maximum was again at 253 mμ, but in this case a minimum appeared at 245 mμ, as shown in Figure 5.

The ratio of the optical densities at 440 and 500 mμ of the brown material which moves with the solvent front was measured. A value of 2.3 was obtained from several determinations. Since this value is critical in determining rate data, a second approach was used which involved the analysis of filtered solutions, by the Sondheimer and Kertesz method *(15)*. The amount of anthocyanin pigment was determined, and the coefficient necessary to give the correct value of pure anthocyanin was calculated. This was calculated to be 2.3 which was identical with the value obtained directly from the chromatographed material.

(c) Aglucone degradation

On standing at room temperature, in either nitrogen or oxygen, the aglucone solution was rapidly decolorized. The reaction appears to be first order with a half-life of 5 minutes at pH 3.40 at 25° C. At higher temperatures the reaction rate is correspondingly higher. On heating the aglucone solution at 45° C. in oxygen for 4 days no precipitate formed.

(d) Strawberry juice

The absorption spectra of the insoluble material isolated from strawberry juice heated in oxygen at 55° C. in ethanol-HCl after 0, 6, and 23 hours are given in

Figure 6. A maximum occurred at 520 mμ, a broad maximum from 430-450 mμ and a minimum at 380 mμ. Here, as in the pure pigment solutions, there was a shift of the 520 mμ maxima to lower wave lengths and a shift of the 380 mμ minima to higher wave lengths.

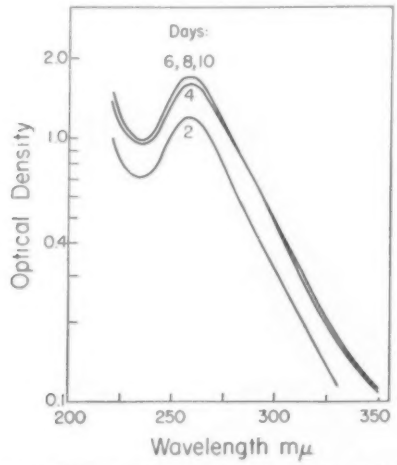

Figure 5. Spectral changes of ethyl acetate soluble breakdown product of pigment at pH 3.4 heated in oxygen at 55° C. In absolute ethanol solvent.

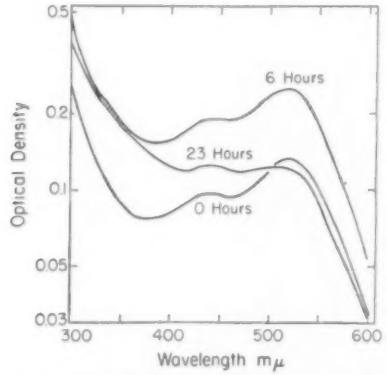

Figure 6. Spectral changes of red-brown precipitate formed in strawberry juice at 55° C. in ethanol-HCl (0.001 M) solvent.

DISCUSSION

The principal breakdown products of the pigment in oxygen were an insoluble red-brown precipitate and a soluble brown material. In nitrogen, only minute amounts of red-brown precipitate were formed for equivalent pigment losses. At least two pathways of formation are possible. One is the conversion or polymerization of the pseudobase of the pigments to the red-brown precipitate. The other is the hydrolysis of the pseudobase to the aglucone with subsequent conversion directly or through intermediates to the red-brown precipitate. In both cases, the brown may arise from the glucose, the red-brown precipitate and, or from colorless breakdown products.

The formation of the red-brown precipitate from the aglucone is unlikely since no precipitate was observed when the aglucone was decolorized in solution. It follows, then, that this precipitate must be formed from the pseudobase of the oxonium salt of the glucoside, or possibly from both.

The effect of pH on the rate of reaction in pure pigment solutions and in strawberry juice seems to indicate that in oxygen the more reactive molecular species is the pseudobase. In nitrogen the rate was comparatively independent of pH, so that both pigment forms may be equally susceptible to breakdown. The slight increase in rate with pH in nitrogen may be due either to oxygen contamination or to the fact that even in the complete absence of oxygen, the pseudobase is the more reactive. If the former is true, the formation of small amount of precipitate may be caused by oxidation of the pseudobase.

Several common spectral characteristics were observed in the insoluble red-brown precipitate obtained from heated pure pigment solution and strawberry juice. In all cases during heating, the absorption maximum of the insoluble material in the 520 mμ region decreased in intensity. The ratio of absorption at 440 mμ to 520 mμ increased. In all cases the absorption maximum in the 520 region shifted toward lower, and the minimum at 380 mμ toward longer, wave lengths.

It appears likely from the combined spectral and chromatographic data that two processes are occurring simultaneously in oxygen. One is the formation of the red-brown precipitate and the other is its degradation to brown products.

The precipitate, in a solution of 95% ethanol (50% HCl), was heated for several hours. Subsequent chromatography of this material indicated the presence of a material with an R_f identical with glucose. There was a shift in the 520 mμ peak to a 530 mμ maximum and a shift in the 380 minimum to lower wave lengths as shown in Figure 5. On chromatographing the heated precipitate in butanol-2 *N* HCl, two spots appeared, one with an R_f of 0.75 (the original material) and another with an R_f of 0.98. The increase in R_f value could indicate either a gross modification of the molecule or possibly that glucose is split off.

The red-brown precipitate does not melt below 300° C. and could not be crystallized. The precipitate was burned and its emission spectrum was examined but the presence of metal cations could not be detected. In conjunction with its low water solubility this indicates its polymeric nature.

The formation of cloudy brownish gels on heating strawberry preserves and jams is probably due, at least in part, to the formation and subsequent breakdown of this red-brown precipitate. Thus the shelf-life of these products is markedly affected by the presence of oxygen. However, as shown in Table 2a, other pathways for pigment destruction become significant at elevated storage temperatures.

SUMMARY

The rate of anthocyanin breakdown in pure solution and in strawberry juice was studied, in nitrogen and oxygen. In both cases it was much faster and pH-dependent in oxygen, whereas in nitrogen the pH had little effect.

The rate of oxidation seems to be directly dependent upon the percentage of pigment existing in the form of the pseudobase.

Acknowledgment

A grant-in-aid from the National Preservers' Association is gratefully acknowledged.

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Quality of Sardines (Clupea pilchardus Walb.) Held Unfrozen and Frozen Prior to Canning

(Manuscript received March 29, 1956)

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An objective study, begun in 1953 *(18)*, has been made of the effects of refrigerated storage on the quality of Yugoslav sardines (*Clupea pilchardus* Walb., the true sardine) immediately prior to canning and throughout a shelf life of the canned product of about 1½ years. The sardines were caught in the months of June, July and August.

Several reports of work with unfrozen and frozen herring used for fresh, frozen, smoked and canned products *(3, 4, 5, 6, 8, 11, 20, 21, 22, 23)* and with the chilling and freezing and subsequent storage of sardines and similar fish *(10, 14, 15, 16)*, are given in the literature. A publication from France *(17)* without experimental data, states that stored frozen sardines produced canned fish of variable quality. In Norway, sprats have been held successfully at temperatures of —16.6° F. (—27° C.) and —31° F. (—35° C.) for a few weeks prior to canning and smoking *(1)*.

A pre-canning keeping time of California pilchards at a temperature of 35° to 40° F. (1.7° to 4.4° C.) of at least 5 days has been suggested *(10)*. In commercial practice, most of these fish are not iced or otherwise refrigerated at sea. They are landed about 12 hours after catching and must be processed within about 4 or 5 hours *(9)*. The canners estimate that brine chilling at sea might extend the packing time to possibly 12 hours *(9)*. The different appraisals of the keeping time may be found in the use in the former case of chemical data as an index of the condition of the fish and in the latter case of the results of organoleptic examination. As shown below, organoleptic examination of sardines, both before and after canning, is considered to offer a fairly reliable index of the suitability of the fish for canning. Chemical tests are considered to act only in a supporting role. The former showed that the longest possible keeping time for unfrozen sardines in ice at a

temperature of 30° to 31° F. (−1.1° to −0.5° C.) was 3 days and for frozen sardines in −4° F. (−20° C.) storage, it was about 1 month.

EXPERIMENTAL

Pertinent data concerning the treatment of the fish of 6 catches used in the experiments are given in Table 1. It was impossible to obtain all samples of commercially-caught fish from any one fishing port, hence the differences in the mode and time of transportation for the various lots. All fish, however, were caught in the same area of the North Adriatic Sea.

Prior to canning, the fresh chilled fish, the stored unfrozen fish, and the fish thawed after removal from frozen storage were examined organoleptically and peroxide determinations were made in the laboratory of the Rijeka Hygiene Institute.

The following tests of canned fish were done at the Chemical Laboratory of the Rijeka Hygiene Institute, and at the Fish Inspection Laboratory, Halifax: (a) organoleptic examination; (b) determination of peroxide value; (c) determination of free fatty acids; (d) determination of salt.

Daily, over a period which varied from 7 to 10 days, a sub-lot, usually a case or wooden box containing about 27 lb. (12 kg.) of fish, was drawn from each lot of stored unfrozen sardines. About 2 lb. (1 kg.) of the fish was used for organoleptic and chemical tests while the remaining fish were canned. The same procedure was followed for the frozen fish except that withdrawals were made at intervals of 3 to 6 weeks. Frozen fish were defrosted in clean fresh water (maximum immersion time, 1 hour) at a temperature of about 59° F. (15° C.). Both the sardines unfrozen since catching and those recently thawed were beheaded and eviscerated by hand, brined for 30 minutes in 25% brine, dried on wire racks for about 3 hours in the sun, fried in olive oil at 230° to 248° F. (110° to 120° C.) for 7 to 8 minutes, drained, and packed. Pure olive oil was added to the cans and the tins were closed and processed 2¼ hours in boiling water at 212° F. (100° C.). About 50 cans (¼ club) were obtained from each sub-lot of fish. All canning operations were performed by regular factory personnel.

Organoleptic examination of the fish prior to canning was carried out by a panel of three. The following aspects of the fish were examined: condition of skin and eyes, color and odor of gills, odor of whole fish, texture of whole fish, condition of bellies after beheading and evisceration, color of flesh near the severed head and in the filleted fish—both within and without the lateral band of dark muscle—and odor and firmness of the filleted fish. The forms used in these examinations listed several obvious stages of degradation for each feature under study. For each aspect the panel decided the number of days of storage permitted; that is, the number of days during which the fish were acceptable.

The Wheeler test for peroxide *(24)* was performed on the fish of the first two catches prior to canning. The beheaded, eviscerated, scaled fish were homogenized. A quantity of 10 g. of the homogenized material was placed in a shaking funnel, desiccated by alkali-free anhydrous sodium sulphate and the fat extracted for 1 hour with 100 ml. low boiling petroleum ether. Twenty ml. of the extract was evaporated to determine fat content and another 20 ml. was used to determine peroxide oxygen. For the latter 50 ml. of fresh solution of 6:4 acetic acid-chloroform containing 1 ml. saturated solution of potassium iodide was added, followed by 100 ml. of 0.05% starch. The iodine liberated was titrated with 0.01 N-thiosulphate solution. A blank test was run under the same conditions. Results are expressed as ml. 0.01 N-thiosulphate per 1 g. of fat.

A modification of the Lea method *(7)* was employed in determining the peroxide number for all sub-lots of fish from Catches III, IV, V, and VI. To 20 ml. extract obtained as above, 20 ml. 2:1 acetic acid-chloroform solution and 2 drops of saturated potassium iodide solution were added. The whole was left in the dark for 10 minutes. The iodine liberated by addition of 15 ml. of 15% solution of potassium iodide was titrated with 0.002 N-thiosulphate solution. Results are given in ml. 0.002 N-thiosulphate per 1 g. of fat.

TABLE 1

Handling and storage conditions for Yugoslav sardines

Catch No.	Lot No.	Elapsed time in hours—catching to cold store	Average temperature of sardines upon arrival at cold store	Method used at cold store to complete chilling or to freeze sardines	Conditions of storage	No. of sub-lots canned
I	1	12		A	F	10
I	2	12		A	E	10
II	3	15	42° F. (5.5° C.)	B	E	10
II	4	15		B	F	8
II	5	15		C	H	5
II	6	15		D	G	5
II	7	15		D	H	5
III	8	32		C	H	5
III	9	32	37.4° F. (3° C.)	D	G	5
III	10	32		D	H	5
IV	11	12		B	E	9
IV	12	12		B	F	8
IV	13	12	38.3° F. (3.5° C.)	A	E	10
IV	14	12		C	H	4
IV	15	12		D	G	4
IV	16	12		D	H	4
V	17	12	42° F. (5.5° C.)	B	E	9
VI	18	15		A	E	9
VI	19	15		A	E	9
VI	20	15		A	E	9
VI	21	15	53° F. (11.7° C.)	A	E	9
VI	22	15		A	E	8
VI	23	15		A	E	9
VI	24	15		A	E	9

Handling from Sea to Cold Store

Catch No.

I (Lots 1, 2)—Uneviscerated, iced in cases within 2 hr. of catching. Boat journey of 10 hr.

II (Lots 3, 4, 5, 6, 7)—Uneviscerated, iced in cases within 3 hr. of catching. Boat journey of 12 hr.

III (Lots 8, 9, 10)—Uneviscerated, iced in cases within 9 hr. of catching. Boat journey of 20 hr.

IV (Lots 11, 12, 13, 14, 15, 16)—Uneviscerated, iced in cases at catching and again 5 hr. later. Boat journey of 10 hr.

V (Lot 17)—Uneviscerated, stowed in cases without ice at sea. Placed in unagitated refrigerated sea water 4 hr. later. Boat and truck journey of 5½ hr.

VI (Lot 18)—Uneviscerated, iced in cases at catching. Boat and truck journey of 5½ hr.

VI (Lot 19)—Uneviscerated, iced in cases at catching. Eviscerated, washed and re-iced 6 hr. later. Boat and truck journey of 5½ hr.

VI (Lot 20)—Uneviscerated, stowed in cases without ice at sea. Iced in cases 6 hr. after catching. Boat and truck journey of 5½ hr.

VI (Lot 21)—Same treatment as Lot 20, but eviscerated before icing.

VI (Lot 22)—Uneviscerated, stowed in cases without ice at sea. Iced in cases 8 hr. after catching. Boat and truck journey of 5½ hr.

VI (Lot 23)—Same treatment as Lot 22, but eviscerated before icing.

VI (Lot 24)—Uneviscerated, salt but not ice added to fish in cases at sea. Sardines washed and iced 8 hr. after catching. Boat and truck journey of 5½ hr.

Code for Method Used at Cold Storage

A—Refrigerated in ice and still air at 30 to 31° F. (−1.1 to −0.5° C.).

B—Unagitated, constantly refrigerated sea water at temperature of 28° F. (−2.2° C.).

C—Unagitated, constantly refrigerated eutectic brine at temperature of −4° F. (−20° C.).

D—Air blast of 1400 ft./min. (7 m./sec.) velocity, refrigerated to 1.5° F. (−17° C.) at start and to −4° F. (−20° C.) at completion of freezing.

Code for Conditions of Storage

E—Top layer of boxed unfrozen sardines buried in ice. Storage room temperature 30 to 31° F. (−1.1 to −0.5° C.).

F—Top layer of boxed unfrozen sardines exposed to air. Storage room temperature 30 to 31° F. (−1.1 to −0.5° C.).

G—Blocks of glazed, frozen sardines stored at temperature of −4° F. (−20° C.).

H—Blocks of unglazed, frozen sardines stored at temperature of −4° F. (−20° C.).

TABLE 2

Permissible storage (days) for unfrozen sardines based on organoleptic examination of the fish before canning (Lot No. corresponds to Lot No. given in Table 1)

Lot No.	Treatment of sardines	Eyes	Skin	Color			Odor				Texture		Broken	
				Outside of head	Gills	Fillet	Exterior	Gills	Viscera	Fillet	Whole fish	Fillet	Fish	Bellies
11	Uneviscerated, iced at sea and partly chilled. Chilled in refrigerated sea water ashore to about 28° F. (—2.2° C.) and stored in ice in 30 to 31° F. (—1.1 to —0.5° C.) room.	2	7	2	2	5-6	2	2	6	6	7	7	7+	2
12	Same as Lot 11, except fish stowed without ice in 30 to 31° F. (—1.1 to —0.5° C.) room.	2	7+	2	2	5-6	3	3	3	3	7+	7	7+	2
13	Uneviscerated, iced at sea and re-iced at 5 hours. Chilled in ice in 30 to 31° F. (—1.1 to —0.5° C.) room and stored therein.	2	7+	2	2	5-6	2	2	2-3	3-6	7+	6-7+	7+	2-3
17	Uneviscerated. Not iced at sea. Chilled in refrigerated sea water ashore to 28° F. (—2.2° C.) and stored in ice in 30 to 31° F. (—1.1 to —0.5° C.) room.	1-2	4	1	1-2	5-6	1	0	2	2	5	4	7	0
18	Same as Lot 13 except not re-iced.	1-2	7+	2-5	4-5	6	4	4	2	5	4-5	6	7+	3-4
19	Same as Lot 18, except that fish eviscerated and washed before icing and storage in 30 to 31° F. (—1.1 to —0.5° C.) room.	....	7+	....	....	5-6	1	....	....	2	7+	5-6	7+	6
20	Uneviscerated, not iced at sea. Chilled in ice in 30 to 31° F. (—1.1 to —0.5° C.) room and stored therein.	1-2	7+	1	3-4	5-6	3	1	2	2	5-6	4-5	7+	0
21	Same as Lot 20, except fish were eviscerated and washed before icing and storage in 30 to 31° F. (—1.1 to —0.5° C.) room.	....	7+	....	....	5-6	1	....	1	1	7	4	7+	2-4
22	Same as Lot 20, except an additional 2 hr. delay before icing was permitted.	1-2	7+	1	4	5-6	1	1	2	3	5-6	4-5	7+	0
23	Same as Lot 22, except fish were eviscerated and washed before icing and storage in 30 to 31° F. (—1.1 to —0.5° C.) room.	....	7+	....	....	5-6	2	....	....	2	5-6	5-6	6-7	3-4
24	Uneviscerated, salted but not iced at sea. Chilled ashore in ice in 30 to 31° F. (—1.1 to —0.5° C.) room and stored therein.	0	7+	0	3-4	4-5	3-4	0	1	1	7+	6	6-7	3-4

+ sign is used where permissible storage time was greater than 7 days.

Examination of the canned fish was carried out by a panel of three according to standard procedures used at the Fish Inspection Laboratory, Halifax. Among the features looked for in the examination were broken fish, broken bellies, torn skin; and odor, flavor, saltiness, and color of the fish flesh. The fish were considered acceptable if a very good standard quality or better product was obtained.

All chemical tests on the canned fish, other than that for salt content, were made in the Rijeka Hygiene Institute Laboratory. Salt content in the fish after draining was determined at the above institution, and in the Fish Inspection Laboratory, Halifax, by the Volhard method *(2)*.

Peroxide determinations on the canned fish were made by the modified Lea method *(7)*.

Free fatty acid determinations for the canned fish were made as follows: to 5 g. oil were added 20 ml. solution 1:1 alcohol: ether, and the mixture was titrated with 0.1 N-sodium hydroxide solution. The results are given in ml. N-sodium hydroxide for 100 g. oil.

RESULTS

Organoleptic examination

Unfrozen Sardines. When examined prior to canning, the fish iced at sea and held uneviscerated in ice ashore were much superior to fish of the same catch iced at later periods, as determined by resistance to (a) reddening on the outside of the head (b) discoloration of the gills (c) development of odors on the outside, in the gills, and on the fillet of the fish and (d) development of broken bellies (Lot 18 vs. Lots 20, 22, Table 2). As judged by all factors with the exception of condition of the eyes, and odor of the viscera, the fish iced at sea and held uneviscerated ashore had a storage life in the unfrozen state of about 3 days. The fish which were not iced until landing or later were not stored because of broken bellies. Examination of the canned fish showed that the sardines iced at sea and held uneviscerated 3 days after catching were acceptable as raw material for canning.

The results of the organoleptic examination of two lots of fish iced at sea (Lots 13 and 18) show some variation. Lot 18 was inferior in texture which is attributed to a combination of the effects of slower cooling and the severity of jolting in the truck journey. Lot 13 was cooled more efficiently because of the extra icing 5 hours after capture. The color and odor of the outside of the head and the gills of the fish from Lot 13 were judged to deteriorate more rapidly than for Lot 18. This was not reflected in the condition of the fish flesh which, on the average, was in the same state of preservation for the two lots after equal periods of storage.

Icing at sea or at later periods did not result in significant differences in the quality of the eviscerated fish appraised prior to canning (Lots 19, 21, 23, Table 2). The sardines had a storage life of 2 days and, if odors were omitted from consideration, a storage life of 3 days. Examination of the canned fish proved to be more selective, the fish iced at sea being always equal to or better than fish iced later with respect to broken bellies, color, texture, and flavor. The latter examination showed all sub-lots to be acceptable as raw material for canning on the day of catching. For the fish stored until the third day after catching, only those which had been iced at sea and some of those iced immediately upon landing were acceptable.

Prior to canning, eviscerated fish showed greater odor development than uneviscerated fish (Lot 19 vs. Lot 18, Table 2), probably due to the exposure of large surface areas to contact with air, but the former suffered fewer broken bellies than the latter (Lots 19, 21, 23 vs. Lots 18, 20, 22, Table 2). The instances where broken bellies prevented storage (Table 2, Lots 17, 20, 22) reflect on the practice of delaying the application of refrigeration too long and possibly indicate rough handling. Little overall difference in quality was evident between eviscerated and uneviscerated fish in storage when both were iced at sea however, as determined prior to canning (Lots 19 and 18, Table 2) and after canning. The latter examination showed that fish were acceptable during 3 days of storage but not thereafter.

No significant difference was noted in the quality of refrigerated sea-water-cooled and ice-cooled fish of the same catch (Lots 11 and 12 vs. Lot 13, Table 2 and Table 3), nor was there a significant difference in quality noted in fish exposed to air in the 30° to 31° F. (−1.1° to −0.5° C.) storage room and in those buried in ice in the same refrigerated room (Lots 1, 2, 3, 4, Table 1; and Lots 11, 12, Tables 1 and 2).

As indicated by most aspects, the fish sprinkled with salt at sea, then iced ashore (Lot 24, Tables 1 and 2) were markedly inferior to the fish iced at sea without the addition of salt. The salted fish, canned on the same day as caught, were not acceptable. They were poor in color, reddening being prevalent; stomachs were unattractive; texture and flavor were poor.

Air-frozen Sardines. Frozen fish stored for 22 to 43 days prior to canning were inferior, when thawed, to the recently-caught, unfrozen catch and about equal to unfrozen fish held 3 days under refrigeration. The color of the flesh of the fish held 43 days in cold storage was satisfactory. For these fish the odor of the outside of the gills and of the viscera was slightly to strongly rancid but that of the fish flesh itself was satisfactory to only slightly rancid, being superior in the glazed fish. The texture of the fish which had been frozen was firm to slightly soft, but acceptable. The reduction in quality of the frozen fish progressed slowly with length of storage on some counts while on others there was little or no observed deterioration after the initial reduction observed in the frozen fish. The glazed and unglazed frozen fish developed progressively stronger odors in the gills, viscera, and on the fish flesh with storage time. There was little concrete evidence to show increase in broken bellies, deterioration in texture or in color over the same periods.

After canning, deterioration in quality, as reflected by worsening of flavor, color, and in some instances texture, was shown to progress with length of storage prior to canning. Sub-lots 22 and 26 days in cold storage proved to be acceptable as raw material for canning, while those held 43 days in cold storage

TABLE 3

Estimated storage life of sardines chilled wholly in ice vs. sardines chilled partially in ice and partially in refrigerated sea water (Lot No. corresponds to Lot No. given in Table 1)

Catch No.	Lot No.	Method of cooling and storing uneviscerated fish	Storage life prior to canning based on organoleptic examination of the canned product for color, texture, and flavor
			(days)
I	1 and 2	Iced at sea and ashore and held in 30 to 31° F. (−1.1 to −0.5° C.) holding room.	3
IV	13	Iced at sea and ashore and held in 30 to 31° F. (−1.1 to −0.5° C.) holding room.	3
VI	18	Iced at sea and ashore and held in 30 to 31° F. (−1.1 to −0.5° C.) holding room.	3
II	3	Iced at sea and partially cooled. Completely cooled in refrigerated sea water on shore, then held in 30 to 31° F. (−1.1 to −0.5° C.) holding room.	2
IV	11 and 12	Iced at sea and partially cooled. Completely cooled in refrigerated sea water on shore, then held in 30 to 31° F. (−1.1 to −0.5° C.) holding room.	3

were on the borderline of acceptability. Those stored for longer periods were not acceptable. The major deficiencies in the pack from the fish held 43 days in low temperature storage, were broken bellies, strong odor, fair to poor color, and poor flavor.

Major differences in odor were observed in the air-frozen unglazed and air-frozen glazed fish prior to canning, those of the unglazed fish being more rancid. For periods of storage substantially longer than about 30 days, the unglazed fish yielded a canned product inferior to that produced from the glazed fish.

Brine-frozen Sardines. Little difference was noted in quality of the air-frozen and brine-frozen fish prior to canning. Generally, fillets from the brine-frozen fish appeared somewhat firmer than those from the air-frozen. The scoring for rancid odors on the exteriors and on the fish flesh showed the brine-frozen sardines of Catch IV in particular to be inferior to air-frozen fish of the same catch.

Fish 22 and 26 days in cold storage proved to be unacceptable as raw material for canning on the basis of the development in the canned fish of (a) objectionable reddening in the flesh along the back and lateral bones (b) objectionable flavors. In contrast, fish 43 days in storage (Catch IV) were acceptable for canning but had deteriorated greatly with longer storage.

Chemical examination.

Unfrozen Sardines. Peroxide development in sardines, handled in various ways, was low and about the same for a period of storage up to 3 days. Thereafter the fish landed un-iced and the fish sprinkled with salt at sea showed a higher peroxide development than the fish iced at sea. It was not possible, however, on the basis of peroxide content, to decide upon a definite storage limit for any of the lots of unfrozen fish.

Air-frozen and Brine-frozen Sardines. Curves A, B, and C (Figure 1) show peroxide determinations for brine-frozen unglazed, air-frozen and glazed, and air-frozen unglazed fish of Catch III respectively. Results for Catch II are in close agreement while curves D, E, F (Figure 1) for Catch IV show a much slower development. The latter fish were better handled and iced at sea than were Catches II and III. Of all catches, values were consistently highest for the brine-frozen fish, next highest for the air-frozen unglazed fish, and lowest for the air-frozen glazed fish. The curves fail to indicate a definite storage limit for the frozen product. Nevertheless, the amount of peroxide appears to be a good index of the handling and storage conditions. Banks *(5)* used a value of 50 ml. 0.002 N-thiosulphate per g. of fat to establish the limit of storage for frozen herring at —4° F. (—20° C.); this level was reached after about 16 weeks of storage. Results from the storage of sardines at this temperature using the same level of peroxide development and an average of the curves given in Figure 1, show the limit of storage to be about 40 days. It should be noted that results given above of the organoleptic examination of the sardines canned from the same supply of fish also suggest a maximum storage time of approximately one month.

As would be expected, retorting was shown to result in a general breakdown of peroxides in all lots of fish. The breakdown was not as complete in the product processed from the older frozen fish as in that processed from frozen fish in storage for shorter periods or that processed from fresh fish and from fish in unfrozen storage. Peroxide values were highest for fish which had been brine-frozen, next highest for the air-frozen unglazed fish, and lowest for the air-frozen, glazed fish.

There was little variation in free fatty acids in the canned fish whether the fish were iced at sea or upon landing, and whether the chilled fish were stored uneviscerated or eviscerated. The canned product from fish which had been salted at sea, then iced ashore, showed a higher free fatty acid content than did that canned from unsalted fish when the raw material was 4 days or less in storage prior to canning.

Fatty acid content of the canned fish was independent of the storage time of the frozen raw material, irrespective of freezing in air or in brine and of the presence or absence of a glaze over the fish. Very low values for free fatty acids were obtained, e.g., the degree of acidity averaged about 2.5 ml. N-NaOH per 100 g. of oil over the full period of cold storage of 153 days (Catch II).

Table 4 shows that the canned product of unglazed air-frozen fish carried little if any more salt than did that of fresh fish. Glazed air-frozen fish after brining and processing had a higher salt content than did air-frozen unglazed fish similarly treated. No explanation is known for this occurrence. The unglazed brine-frozen fish when brined and canned was much more salty than the fish brined and canned from the fresh supply (Table 5). This increase, probably the result of too slow freezing in brine and too high a storage temperature, was sufficient to raise the salt content of the fish canned from brine-frozen fish above the percentage acceptable from the standpoint of taste, this being about 2%.

TABLE 4

Salt content of the canned fish (air-frozen fish and fresh fish controls used for canning)

Catch No.	Days in cold storage	Lot No. of unglazed fish used for canning (corresponds to lot no. given in Table 1)	% Salt	Lot No. of glazed fish used for canning (corresponds to lot no. given in Table 1)	% Salt
II	26	7	1.60	6	1.45
II	72	7	1.15	6	2.10
II	103	7	0.90	6	2.60
II	153	7	0.80	6	
II	0 (fresh controls)	—	1.58	—	1.58
IV	43	16	1.43	15	4.14
IV	74	16	1.03	15	
IV	0 (fresh controls)	—	1.40	—	1.40

TABLE 5

Salt content of the canned fish (brine-frozen fish and fresh fish controls used for canning)

Catch No.	Days in cold storage	Lot No. of unglazed fish used for canning (corresponds to lot no. given in Table 1)	% Salt
II	26	5	4.25
II	72	5	3.80
II	103	5	3.53
II	153	5	2.52
II	0 (fresh controls)	—	1.58
IV	43	14	1.54
IV	74	14	3.01
IV	0 (fresh controls)	—	1.40

DISCUSSION

Various exterior aspects of both frozen and unfrozen sardines, such as the appearance of the eyes and the gills and the odor of the exterior, the viscera, and the gills, gave the impression that deterioration on storage was proceeding at a much faster rate than the apparent condition of the flesh of the fish indicated. Examination of fish prior to canning should take into account the condition of both the whole fish and the fish flesh. For this reason, estimated over-all storage life reported above has been judged without too much emphasis on the condition of the eyes and the viscera (Table 2). For frozen sardines, an examination of the fish prior to canning may be of less value than in the case of the unfrozen catch. For example, for Catch IV the air-frozen sardines 43 days in storage appeared to be inferior to recently-caught, unfrozen fish but not appreciably inferior to 3-day-old unfrozen fish. In contrast, examination of fish processed from the same frozen and unfrozen sardines showed the frozen fish to be considerably inferior to the 3-day-old unfrozen catch.

Organoleptic examination of brine-frozen fish prior to canning was found to give a poor indication of the quality of the fish after canning. Specifically, for both air-frozen and brine-frozen fish, extensive belly breakage, strong odors, and fair to poor color, not picked up in the raw material, were noted when the processed fish were examined. As an index of quality of the fish after canning, there would appear to be reason to question the infallibility of an organoleptic examination of fish thawed after removal from low temperature storage. This is probably mainly because of fat oxidation.

The present work suggests that organoleptic examination of unfrozen fish, to be of greatest value, should stress:

(1) Condition of belly wall.

(2) Odor of the fish flesh (particularly for eviscerated fish in storage).

(3) Age of fish since catching.

For frozen fish, thawed for processing, the organoleptic examination should stress:

(1) Odor of the fish flesh.

(2) Texture of the fish flesh.

(3) Condition of the belly wall.

(4) Age of the fish since catching.

The above factors should be correlated with examination of the canned product to give a proper assessment of quality.

The necessity of icing sardines soon after catching rules against the practice of transporting the fish uniced from grounds to factory when journeys of several hours are involved. The possibility of extending keeping time of the unfrozen fish to 3 days and of making freezing a worthwhile proposition exists only when fish are iced either on the grounds or at a nearby shore location and when the fish are handled without crushing in their cases both before and after icing.

Cooling by means of finely crushed or flaked ice is effective. It is of no benefit to supplement such chilling means later by cooling in refrigerated seawater. On the other hand, it would be of value to measure the effect of the use of refrigerated seawater at time of catching in comparison to the effect of the use of ice.

Peroxide development was greatest in brine-frozen fish. This parallels experience with the storage of herring *(4)*. While rancidity may be the limiting factor in determining the conditions of storage of sardines, other factors play a significant part in determining the quality of the frozen fish. To illustrate, the fish canned from the glazed and unglazed air-frozen lots (Catch IV, Lots 15, 16) were judged to be on the borderline of acceptabilty due to inferior flavor, color, and texture yet brine-frozen fish of the same catch which showed a higher peroxide development than did the air-frozen fish (Figure 1) yielded an acceptable canned product.

Commercial air-freezing and storage of sardines should be conducted under better conditions than were

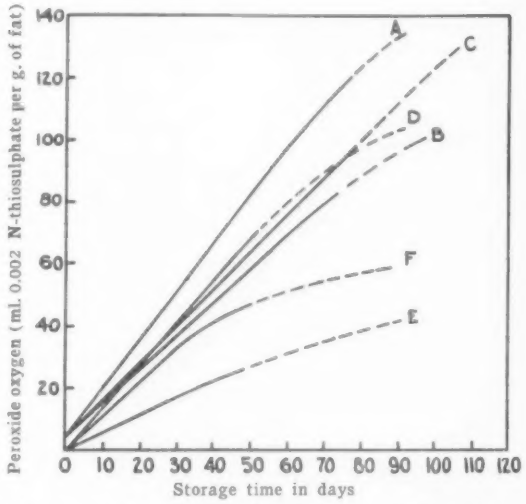

Figure 1. The oxidation of the fat in sardines stored at —4° F. (—20° C.).

B. Sardines of Lot 9, Catch III, frozen in rapidly moving air, then glazed and stored in still air.

E. Sardines of Lot 15, Catch IV, treated in the same manner as B.

C. Sardines of Lot 10, Catch III, frozen in rapidly moving air, and stored unglazed in still air.

F. Sardines of Lot 16, Catch IV, treated in the same manner as C.

A. Sardines of Lot 8, Catch III, frozen in brine of eutectic concentration and stored unglazed in still air.

D. Sardines of Lot 14, Catch IV, treated in the same manner as A.

available for these experiments. A storage temperature at least as low as —20° F. (—29° C.) is recommended. Dry freezing in blocks with subsequent glazing and use of antioxidants such as ascorbic acid or possibly BHA (Butylated hydroxyanisole) should be considered to reduce oxidation during storage. These practices might extend appreciably the storage life of one month determined by these experiments. Attention is drawn also to information from Norway on the use of alginate jellies for freezing *(13, 19)* as this technique might well be applicable to the Yugoslav-caught sardine. Norwegian techniques of freezing in metal boxes and thawing by means of water used on the outside of the boxes *(12)* should be considered as well since it is necessary to keep the percentage of waste resulting from broken fish to a minimum.

While brine-freezing of sardines should not be discouraged if the method appears to have an economic advantage, commercial freezing should be preceded by still further experimental freezing to determine minimum standards for reddening of the flesh and salt uptake by the fish as the result of such freezing and subsequent dry storage.

It is recommended also that the salt content of the fish both before and after defrosting in water be established and that brining of the sardines prior to drying be controlled to give an acceptable salt content for the canned product.

CONCLUSIONS AND RECOMMENDATIONS

Sardines, to be of good canning quality, should be iced in boxes within two or three hours of catching in a manner which prevents crushing. Fish handled in this manner should be held no longer than three days in unfrozen storage prior to canning. Evisceration of sardines prior to storage is not necessary once these conditions are observed. After the sardines are cooled and placed in storage at 30 to 31° F. (—1.1 to —0.5° C.), the presence or absence of ice over the fish does not affect the quality of the fish for canning.

Only strictly fresh sardines, iced and handled as specified, should be frozen for later canning. Glazed and unglazed air-frozen sardines can be held at a temperature of —4° F. (—20° C.) in a condition acceptable for canning for a period of up to one month. A storage temperautre of about —20° F. (—29° C.) is recommended for use in commercial practice.

Organoleptic examination of the fish flesh both prior to and after canning is recommended to give a proper assessment of quality for canning.

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The Shear-Press—An Instrument for Measuring the Quality of Foods. IV. Application to Asparagus[a]

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(Manuscript received April 23, 1956)

THE SHEAR-PRESS, A MULTIPURPOSE INSTRUMENT, has been used to measure the texture characteristics of soaked beans *(4)*, lima beans *(5)*, sweet corn *(6)*, peas *(7)*, and chicken flesh *(2)*. This paper is a study of its application to measure texture of raw green asparagus, using the recently developed asparagus test cell and blade (Figures 1 and 2). Texture is defined here as both toughness and fibrousness.

Processed asparagus, which is free from fiber, is highly prized by the consumer. In the U. S. grades for green asparagus *(15)* tough and fibrous stalks are considered, among other factors, as affecting canning and freezing quality. These grades also indirectly estimate fiber by determining the weight of spears in a sample which contains an insufficient amount of green color. The general assumption here is that usually (although not necessarily) the white tissues in the spear are more fibrous than the green portions.

In U. S. grades for canned asparagus 40 out of 100 points are allotted to tenderness which takes into consideration both toughness and fibrousness *(16)*. No sub-standard limits have been set for the canned product by the Food and Drug Administration. An industry study indicated that the minimum acceptable level for fiber in frozen asparagus is 0.48% as determined by the alkali digestion method or 0.59% by the blender method *(8)*. These values are assigned to fiber in the area 4½-5 inches from the tip.

Complementing the shear-press work is the determination of fiber changes which take place in raw green asparagus during refrigerated storage up to five days duration. This is especially important when the processor must hold asparagus in storage because of a glut of raw material. Some workers have shown an increase in fibrousness or toughness with increased duration of storage *(1, 10)* while Scott and Kramer *(11)* have shown a slight decrease in storage. To clarify these points the following work describes fiber changes as affected by duration of storage and pre-storage and storage treatments.

MATERIALS AND METHODS

Design of the asparagus blade and test cell. The asparagus test cells shown in Figures 1 and 2 are easily interchangeable with the pea and corn cells of the shear-press. The single blade is interchangeable with the grids of the pea box and plunger for the corn box. The blade was first developed with a straight cutting edge. As shown in Figure 1, it is 3¼ inches wide x 3½ inches long x 42/1000 of an inch thick. The 1955 modification of the blade (Figure 2) is 2¾ inches wide x 3⅞ inches long and 37/1000 of an inch in thickness. There is a 1¾ inch cutting surface between the guides which aid in directing the blade into the slot and press the asparagus together before severing.

The asparagus cell as originally constructed and shown in Figure 1 has fill area dimensions of 3⅛ inch width and 3¼ inch height. The cell is grooved ⅛ of an inch on each side to guide the blade on a direct course through the raw asparagus sample. The 1955 cell (Figure 2) was only slightly modified from 1954.

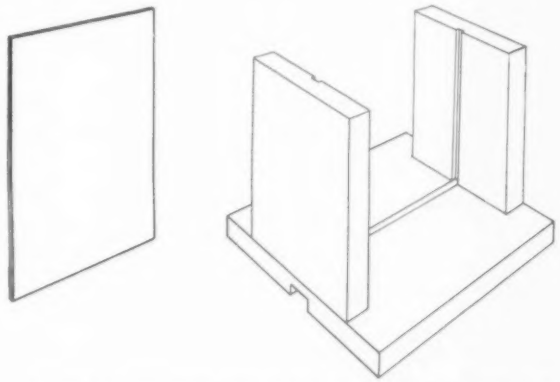

Figure 1. Perspective view of the 1954 shear-press blade and test cell.

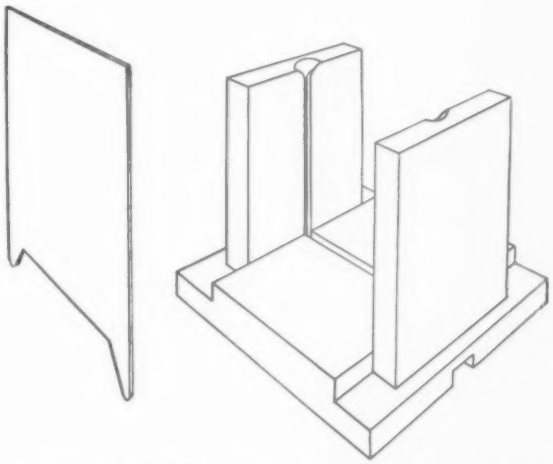

Figure 2. Perspective view of the 1955 shear-press blade and test cell.

The groove for guiding the blade has been widened at the top to catch and aid the blade in its downward movement. Its fill area dimensions are 2⅝ inches in width by 2⅝ inches in height which is slightly smaller than the 1954 cell and holds fewer asparagus spears. The fill area is about 6.92 square inches as compared to 10.14 square inches for the 1954 cell. The 1955 cell will hold 12-20 spears compared with 20-35 of the 1954 cell. The bottoms of both cells contain a continuous slit ⅛ of an inch wide to accommodate the blade. The blade must pass through all asparagus

[a] Scientific publication No. A551, Contribution No. 2695, of the Maryland Agricultural Experiment Station (Department of Horticulture).

spears, sever each completely and pass through the bottom slit before being returned to the start position.

Raw product handling. Asparagus spears were harvested from a commercial planting for 3 successive weeks during the 1955 harvest season. The spears were cut at an average length of 8 inches. They were placed in field boxes and transported to a local freezing plant. It took approximately 5 hours to transport the product from field to unloading platform at the plant. A 20-pound sample was randomly collected from boxes and then divided into half for grading. The product was then graded in accordance with U. S. grades for green asparagus by a Federal-state inspector, for U. S. No. 1's, culls, and butts *(15)*. Special attention was given to the factor of "insufficient green spears" which are those spears having less than 5 inches of green color on the stalk. The fibrousness or toughness was recorded using the asparagus cell and blade of the shear-press. Readings were made at a point on the spear 6 inches from the tip and on the same spears at a point 5 inches from the tip. This procedure was repeated five times for each sample. Readings obtained were the peak readings on the G. E. strain gauge as described in the operation of the shear-press *(7)*. Piston speed was set at 5½, which is equivalent to 8 seconds per inch of downward movement. The portion of the spear from the 5-inch to the 6-inch point and the portion from the tip to the 5-inch point were kept separated. At the end of the grading and shear-press evaluation each group was blanched, packaged and frozen.

Simultaneously 45-pound samples of asparagus were prepared for storage. The treatments are as follows:

Hydrocooled in 34° F. water for 6 minutes and placed in 35-40° F. storage with butts immersed in water.

Hydrocooled in 34° F. water for 6 minutes and placed in 35-40° F. storage in regular field boxes.

No hydrocooling, placed in 35-40° F. storage with butts immersed in water.

No hydrocooling, placed in 35-40° F. storage in regular field boxes. Check, equivalent to regular commercial practice.

The relative humidity was not controlled and ranged 75-85%.

Ten-pound samples of asparagus of each treatment were removed from storage after 1, 2, 3, and 5 days. After removal, the asparagus was again graded by a Federal-state inspector, shear-press values taken and samples frozen as described in the procedure above for the original samples. This experimental procedure was repeated for 3 successive weeks during the 1955 harvest season.

Frozen asparagus. Fiber determinations were made on the cooked, drained frozen material. The cooking time was 20 minutes in boiling water. The blender-fiber method was used *(13)*. Fiber was determined on the tip to 5-inch section and the 5-6 inch section. Fiber determination of the 5-6 inch, and the tip-5 inch section was correlated with shear-press values. All fiber values are reported in percentage wet weight basis.

Percent total solids using the vacuum-oven for drying were determined on each lot, for each storage date, for both the 5-6 inch, and the tip-5 inch segments.

The frozen asparagus was held in storage approximately two months before fiber and total solids analysis.

RESULTS AND DISCUSSION

The results deal with the use of the shear-press values of raw green asparagus to predict fibrousness of frozen asparagus, and fiber changes that occur in raw asparagus in refrigerated storage as affected by hydrocooling plus wet storage, hydrocooling plus dry storage, wet and dry storage.

Shear-press. The asparagus cell and blade (Figure 1) used in 1954 in the sampling study *(9)* showed a correlation of +.76 between shear-press readings of raw green asparagus at the 6-inch point and percent fiber of canned asparagus in the 4½ inch-6 inch area. The relation between the 4½ inch point shear-press readings of raw green asparagus and tip-4½ inch area fiber readings was +.14 which indicates fiber or toughness is very difficult to measure in the tip to 4½ inch segment of the spear. The correlation coefficient (+.76) between shear-press readings at the 6 inch point and percent fiber showed sufficient promise to continue the work with improved sampling techniques and an improved test cell.

Since some difficulties were encountered in the use of the 1954 cell, changes as shown in Figure 2 were made in the asparagus cell and blade prior to the 1955 season. The results with this modified test cell are shown in Figure 3. The correlation coefficient of +.90

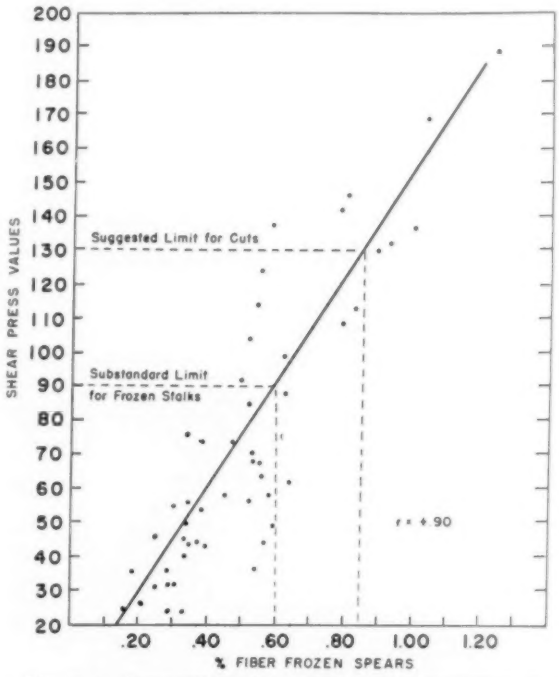

Figure 3. Shear-press values 6-inch point (raw green asparagus) on percent fiber (blender method) frozen asparagus 5–6-inch area.

between shear-press at the 6-inch point of raw green asparagus and percent fiber in the 5-6 inch portion of the frozen stalk is a substantial improvement over results obtained with the original cell. A shear-press value of 90 is equivalent to the sub-standard limit for frozen stalks. Values above 130 are of doubtful acceptability in any style pack.

The correlation coefficient of +.44 between shear-press at the 5-inch point of raw green asparagus and percent fiber in the tip-5 inch portion of the frozen stalks shows some improvement over 1954 work but is not high enough for prediction purposes.

The relation of values obtained with the original cell to those obtained with the new cell is shown in Table 1. It may be noted that for every increase of 10 pounds obtained with the new cell, there is an increase of

approximately 16 pounds when the original cell is used. This difference is largely due to the relation of the cutting area of the two cells, where the ratio of the area of the original cell to the new cell is approximately 1.5.

The relation of shear-press values on raw green asparagus to the fiber content of frozen asparagus is also shown in Table 1. The blender method was shown to be highly correlated with panel scores, yielding a correlation coefficient of —.94 *(3)*. The alkali digestion method, which is identical to the Food and Drug Administration method for canned green and wax beans, was not as highly correlated with panel scores *(11)*. Comparison of the two methods for measuring fiber was derived from data obtained in connection with a study on mandatory standards *(9)*, and from unpublished data by Twigg *(14)*.

TABLE 1

Relation of shear-press values (raw green asparagus) as obtained with different cells, to fiber content and acceptability

Shear Press		Fiber, percent		Suggested acceptability limits
1955 cell ($r = .90$)	1954 cell ($r = .76$)	Blender method	Alkali method	
20	110	.14	.16	Very tender
30	126	.21	.21	Tender
40	142	.27	.25	Tender
50	158	.34	.30	Slightly fibrous
60	173	.40	.35	Slightly fibrous
70	188	.46	.39	Fibrous
80	204	.52	.43	Fibrous
90	220	.59	.48	Substandard limit for frozen stalks
100	237	.66	.53	
110	253	.73	.58	
120	268	.78	.62	Acceptable as cuts only
130	284	.84	.66	
140	300	.91	.70	
150	315	.97	.74	Doubtful acceptability in any style pack
160	330	1.03	.78	

The suggested acceptability limits give the approximate breaking points between grades and were also derived from the above data in which the sub-standard limit for frozen stalks was set rather precisely at .48% fiber as determined by the alkali digestion method.

Cooling and storage experiment. The effects of cooling and various storage periods on the texture or fiber of raw asparagus measured by the shear-press shows a number of important differences. As shown in Table 2, there seems to be little effect of a six-minute hydrocool in 34° F. water on any of the asparagus, although that which was hydrocooled and stored dry was significantly lower than check in shear-press values. The great differences in shear-press values of the raw asparagus appear between the check sample (dry) and the samples stored with the butts in water. The dry or check treatment is significantly higher in shear-press readings than all other treatments. In the combined data there is a significant difference between storage days, but there is no significant interaction between storage and treatment although data shown in Figure 4 point out a substantial reduction in shear-press values in the material stored wet while there is a slight increase in material stored dry.

TABLE 2

Mean shear-press values at the 6-inch point of fresh asparagus immediately after harvest and when taken from 35° to 40° F. storage after 1, 2, 3, and 5 days.

Treatment	Days in storage					Mean
	0	1	2	3	5	
1 Hydrocool + butts in water	95	55	48	53	51	60
2 Hydrocool + dry storage	95	78	82	87	80	84
3 Butts in water	95	61	52	60	40	61
4 Dry storage	95	89	106	83	116	98
Mean	95	71	72	71	72	

LSD (5%) for treatment means 8; for storage means 7; for individual table values, 10. Treatment × storage interaction, n.s.

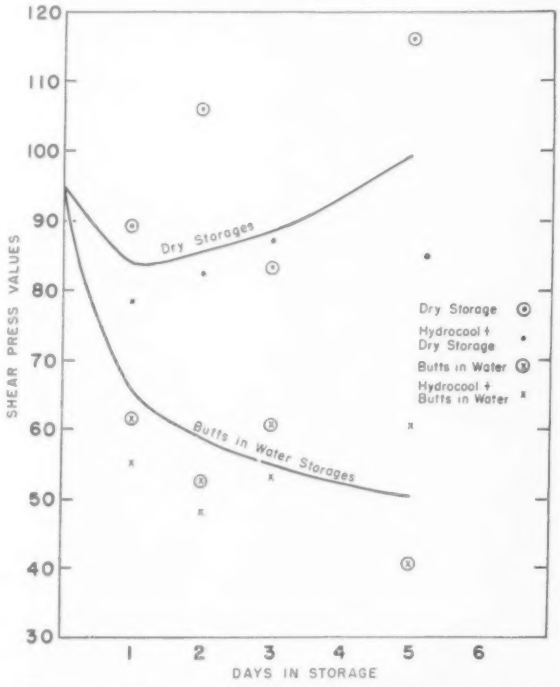

Figure 4. Shear-press values of raw green asparagus immediately after harvest and when taken from storage after 1, 2, 3, and 5 days.

It also may be noted that shear-press values when taken immediately after harvest were significantly different from all other storage shear-press values. This is probably due to a drying out and loss of turgidity in the spear which occurred after harvest and during transportation to the processing plant. This would tend to give a higher initial value since the effect is the same as a regular dry storage treatment.

There is no significant difference in fiber of the two wet-treated samples from percent fiber measurement of cooked drained frozen asparagus; however, there is a significant difference between the wet and the dry method of storage as shown in Table 3 and Figure 5. After two days of dry storage it is doubtful whether the spears should be used for frozen 5-inch stalks while the material stored wet is still usable for a spear pack after 5 days. In asparagus stored dry, hydrocooling had

TABLE 3

Mean percent fiber* values 5- to 6-inch area of cooked, drained asparagus from samples frozen after harvest and when taken from 35° to 40° F. storage after 1, 2, 3, and 5 days.

Treatment	Days in storage					Mean
	0	1	2	3	5	
1 Hydrocool + butts in water	.47	.37	.35	.36	.36	.38
2 Hydrocool + dry storage	.47	.58	.59	.70	.71	.61
3 Butts in water	.47	.42	.31	.32	.32	.37
4 Dry storage	.47	.63	.74	.65	.73	.65
Mean	.47	.50	.50	.51	.54	

*Wet weight basis.
LSD (5%) for treatment means .11; individual table values, .29.
F values:
Storage, n.s.
Treatment × storage interaction, n.s.

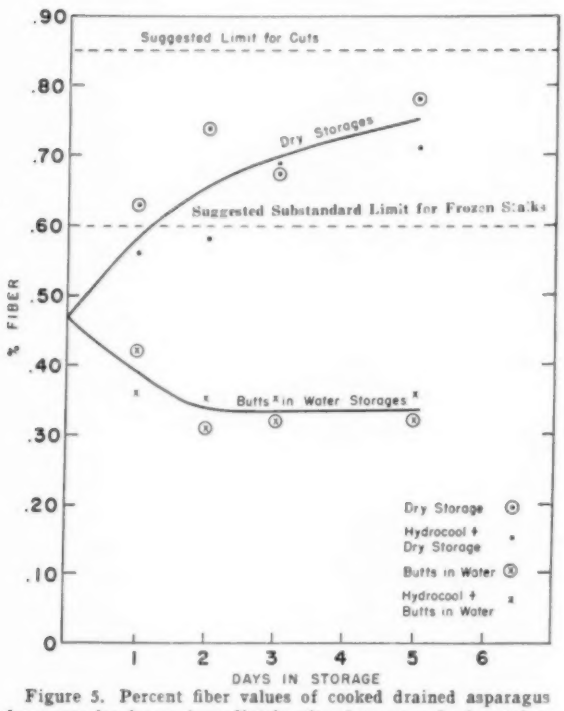

Figure 5. Percent fiber values of cooked drained asparagus from samples frozen immediately after harvest and when taken from storage after 1, 2, 3, and 5 days.

no significant effect in reducing the toughness of the spears.

From data in Table 4, it can be seen that a sample of raw spears showing insufficient green color decreased in weight during storage, the greatest decrease being in the spears which were stored with the bottom portion

TABLE 4

Mean weight of insufficient green spears in 10-lb. sample immediately after harvest and when taken from 35° to 40° F. storage after 1, 2, 3, and 5 days.

Treatment	Days in storage					Mean
	0	1	2	3	5	
1 Hydrocool + butts in water	.75	.36	.41	.24	.33	.43
2 Hydrocool + dry storage	.75	.78	.75	.73	.64	.73
3 Butts in water	.75	.38	.50	.15	.20	.40
4 Dry storage	.75	.37	.50	.68	.52	.56
Mean	.75	.47	.54	.45	.42	

LSD (5%) for treatment means .093; for storage means .091.

in water. The check sample is significantly lower than the samples hydrocooled and then stored dry. A check of marked spears during the 5-day storage in each of the 3 replicated experiments showed no appreciable elongation at this temperature. It is possible that some of the purple anthocyanin pigments may disappear upon storage. This makes it easier to discern the borderline between white and green portions, since the purple color would appear largely as more green asparagus.

The correlation coefficients between insufficient green color of raw asparagus and the shear-press value at the 6-inch point of raw asparagus, and fiber of the 5-6 inch portion of frozen asparagus are +.67 and +.65, respectively. These values indicate that the visual estimation of the white color area (which might be considered fiber) is significantly related to actual fiber. A definite need exists, however, for a more precise method to measure this fiber in the raw product.

It might appear that spears which were stored without contact with water should have a higher total solids content than spears stored wet. Although such a tendency is indicated in the data shown in Table 5, statistically significant differences attributable to treatments or storage could not be demonstrated. Furthermore, when total solids values were adjusted by subtracting fiber from total solids for each treatment, the "fiber free solids" were practically equal in value (Table 6).

TABLE 5

Mean percent total solids * 5- to 6-inch area of cooked, drained asparagus from samples frozen after harvest and when taken from 35° to 40° F. storage after 1, 2, 3, and 5 days.

Treatment	Days in storage					Mean
	0	1	2	3	5	
1 Hydrocool + butts in water	5.22	5.00	5.06	5.35	4.52	5.03
2 Hydrocool + dry storage	5.22	4.76	5.69	5.52	5.13	5.26
3 Butts in water	5.22	5.12	5.15	5.08	4.46	5.00
4 Dry storage	5.22	5.46	4.70	5.57	5.72	5.33
Mean	5.22	5.09	5.15	5.38	4.96	5.16

*Wet weight basis.
F values:
Treatment, n.s.
Storage, n.s.
Replication—significant at 5% level.
Treatment × storage interaction, n.s.

TABLE 6

Calculation of fiber free solids from mean data for the various treatments.

Treatment	(1) Hydrocool + Butts in Water	(2) Hydrocool + Dry Storage	(3) Butts in Water	(4) Dry Storage
Total Solids[1]	5.03	5.26	5.00	5.33
Fiber[1]	.38	.61	.37	.65
Fiber Free Solids	4.65	4.65	4.63	4.68

[1] Reported in percentage wet weight basis.

The total solids and fiber presented are for identical samples throughout the experiments. The samples which were stored wet show a slight reduction (.05 g.) in total solids whereas the increase in fiber is in the order of 75%. It may therefore be concluded that the higher solids content of the dry stored material is attributable to the presence of greater quantities of fiber or fiber-like structures.

SUMMARY AND CONCLUSIONS

The modified asparagus cell and blade of the shear-press when applied to the raw spears at a point 6 inches from the tip gave a correlation of 0.90 with fiber readings of frozen asparagus from the area 5-6 inches from the tip. A shear-press value of 90 corresponded with .60% fiber (blender method) which is the maximum acceptable value for frozen spears. A shear-press value of 130 corresponded with .85% fiber (blender method) which is the suggested maximum acceptable value for cuts.

Although there is a significant correlation between insufficient green color of raw asparagus and percent fiber of frozen asparagus (+.65), this relationship is not sufficiently accurate to serve as an objective method for determining fiber in asparagus.

In the hydrocooling and refrigerated (34-40° F.) storage experiments the effect of hydrocooling in reducing the fiber or toughness in raw asparagus was minor while storage with butts in water showed an actual decrease of .11%. Asparagus stored dry showed an increase of .24%. This water treatment had no effect on percent total solids other than fiber.

Results show asparagus packers, who in some years must hold asparagus in refrigerated storage for an appreciable length of time, should make provisions for some method of wetting during storage since storage with butts in water was more effective than hydrocooling alone in reducing fiber or toughness. Commercially, this might be accomplished by a continuous spray or mist. It should be stated, however, that this continuous wetting has not been evaluated in this work and care should be taken before subjecting the full receipts to this treatment.

Acknowledgment

Acknowledgment is gratefully made particularly to Shoreland Freezers, Inc. in Maryland and growers, processors and state and federal graders of Maryland, Delaware and New Jersey who provided raw material, facilities, labor and technical assistance which made this work possible.

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Notes and Letters

Detection of Hydrogen Sulfide in Packaged Meats and in Broken-Out Shell Eggs

The role of hydrogen sulfide-producing bacteria in the discoloration of meats has been described by Jensen *(1)*. In a study of discoloration and spoilage of packaged self-service meats, a simple technique was employed for detection of H_2S in the packaged product. Later, this method was used to determine the presence of sulfide-producing organisms in shell eggs. Formation of H_2S was considered as one criterion of spoilage of packaged meats and of eggs.

Whatman No. 2 filter paper was cut into strips 1½ inches long by ½ inch wide. The paper strips were impregnated with lead acetate in accordance with the directions given by the Society of American Bacteriologists Committee on Bacteriological Technique *(3)*.

Strips prepared in this manner were dried at room temperature, placed in petri dishes, and sterilized by autoclaving for 20 minutes at 121° C.

Beef steaks, purchased from local grocery stores, were cut into pieces approximately 3 inches by 2½ inches by ½ inch in size. Care was taken to prevent contamination from cutting tools or from the chopping block. Samples were allowed to "brighten" by exposing

them to air for 20 to 30 minutes in a refrigerator at 4.4°-1° C. and were then packaged. One or two paper strips were placed in packages prior to sealing, and packages of meat were stored at temperatures above freezing. Formation of black lead sulfide on the paper strips indicated the development of H_2S.

Eggs classified as current receipts, clean eggs, and dirty eggs were obtained from a commercial source. The eggs were stored in cases in a room in which the temperature ranged from 0.6° to 1.7° C. and the relative humidity varied from 80 to 90%. Samples were taken from the cases after storage for 7 to 12 weeks. Prior to breaking the eggs, the shells were disinfected by using the technique described by McNally *(2)*. The egg contents were emptied into small jars containing 25 ml. of double strength fluid thioglycollate medium (Difco) in accordance with the method of Wolk, McNally, and Spicknall *(4)*. The jars were shaken in order to mix the egg material and broth and then incubated at room temperature (23° to 27° C.) for 4 days. At the end of the incubation period, subcultures were made on tryptone glucose extract agar (Difco) slants. These tubes were incubated for an additional 4 days; upon microscopic examination of slant growth the presence of bacteria confirmed infection in the eggs. For H_2S determinations, a lead acetate filter paper strip was placed between the mouth of the jar and the lid, so that the paper strip extended to the surface of the egg-broth mixture. This test was carried out immediately after the contents of the jars were subcultured on slants, and observations made for blackening of the strips after 4 days. During the storage period, 408 eggs were tested for infection and for formation of H_2S.

Average keeping times of packaged beef as determined by several methods are given in Table 1. Formation of H_2S was followed by off-odor and slime formation in that order. Blackening of the filter paper strips generally was more pronounced when materials having low rates of gas transmission were employed as wrappers than was observed with materials of greater permeability. The interval between detection of H_2S and the other evidences of spoilage appeared to depend upon storage temperature and differences in growth rates of surface organisms when different materials were used.

TABLE 1

Keeping times of packaged beef as determined by development of H_2S, off-odor, and slime formation [1]

Packaging material	Temp. (°C.)	Storage life (days) measured by		
		H_2S	Off-odor	Slime formation
Moistureproof cellophane	4.4	5	7	11
Semi-moistureproof cellophane	4.4	—	5	8
Rubber hydrochloride	4.4	—	7	8
	7.2	5	6	8
Polystyrene	4.4	5	7	11
	7.2	5	6	8
Polyvinylidene chloride	4.4	6	11	12
Cellophane laminated to polyvinylidene chloride	4.4	11	12	16
	10.0	5	5	
Wax coated moistureproof cellophane	7.2	9	12	

[1] Storage conditions:
Closed refrigerators
Relative humidity 70-75%

As shown in Table 2, the majority of infections of eggs by bacteria other than cocci were accompanied by production of H_2S in the egg-broth mixture. Bacteria of the types listed were recovered from all eggs with positive H_2S readings. Apparently, Gram-positive cocci were not as important in causing this type of spoilage as were the other organisms.

TABLE 2

Occurrence of H_2S and bacteria associated with formation of the gas in broken-out shell eggs [1]

Types of organisms	No. of infections	No. of times H_2S noted	Percent incidence of H_2S
Gram-positive sporeforming rods	71	49	69
Gram-positive cocci	104	35	34
Gram-negative rods	34	23	68
Gram-positive non-sporeforming rods	9	6	67

[1] Storage conditions:
Temperature 0.6-1.7° C. (33.35° F.)
Relative Humidity 80-90%

The use of filter paper strips impregnated with lead acetate provides a simple method for determining production of H_2S and serves as an adjunct to detection of spoilage of packaged fresh meats and of broken-out shell eggs. The test may be used in routine examination of these products in association with other criteria for microbiological spoilage.

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Food Processing Laboratory
Iowa State College
Ames, Iowa

LITERATURE CITED

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This isn't the gigantic mill that it appears to be. Instead, it's a junior edition of a full-sized electrolytic tinning line. It measures a mere 100-feet long as compared to the 340-foot length of its big brothers in actual production.

Despite its comparatively small size, the job assigned to this miniature mill is a big one. Located in the new United States Steel Applied Research Laboratories, Monroeville, Pa., this pilot line transforms roll upon roll of 6-inch steel strip into shining tinplate at the rate of 800 feet per minute.

The tinplate produced on this pilot line is used for research studies in United States Steel's continuing research campaign to improve the protective qualities of tinplate and to make even better cans for foods and the variety of products packaged in cans. These objectives are so important that more than ten thousand tests are made on tinplate each week in the Applied Research Laboratory.

By working in close cooperation with the tin container and food packing industries, United States Steel Research Engineers have been able to contribute substantially to the production of finer, more protective tinplate products, which, in turn add to the ever-expanding variety of canned goods to be found in the marketplaces of the world. It illustrates how United States Steel is constantly working to give America finer and more efficient products made of steel.

USS TINPLATE

UNITED STATES STEEL CORPORATION
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UNITED STATES STEEL

(Continued from page 34 preceding technical papers)

In graduate work relatively few courses are offered or required in food or dairy technology. Minor subjects from the fields of physical, biological or engineering sciences are selected to develop the foundations needed for research in the broad field of foods. Completing a research problem and writing a thesis in the chosen field is a requirement for the Ph.D.

Recording an infra-red spectrum.

Quality of the faculty is as important as the content of the curriculum. The teaching staff of 10 at Illinois represents a widely varied group with mixed industrial and academic background, some young, some with many years of experience. Each has a special field of competence and in addition to teaching is active in research. This group and their respective interests are:

E. O. HERREID, Professor of Dairy Technology—proteins in market milk

F. A. KUMMEROW, Associate Professor of Food Chemistry—chemistry of fats and oils

A. I. NELSON, Associate Professor Food Processing—food processing and drying

Z. J. ORDAL, Associate Professor of Food Microbiology—microbial growth and sporulation

M. P. STEINBERG, Assistant Professor Food Engineering—food engineering and refrigeration

JOSEPH TOBIAS, Assistant Professor Dairy Technology—quality of dairy products.

P. H. TRACY, Professor Dairy Technology—ice cream and condensed milk

S. L. TUCKEY, Associate Professor of Dairy Technology—fermented milk products and cheese

R. McL. WHITNEY, Associate Professor Dairy Technology—physical chemistry of proteins

L. D. WITTER, Assistant Professor of Food Microbiology—microbiology of dairy products

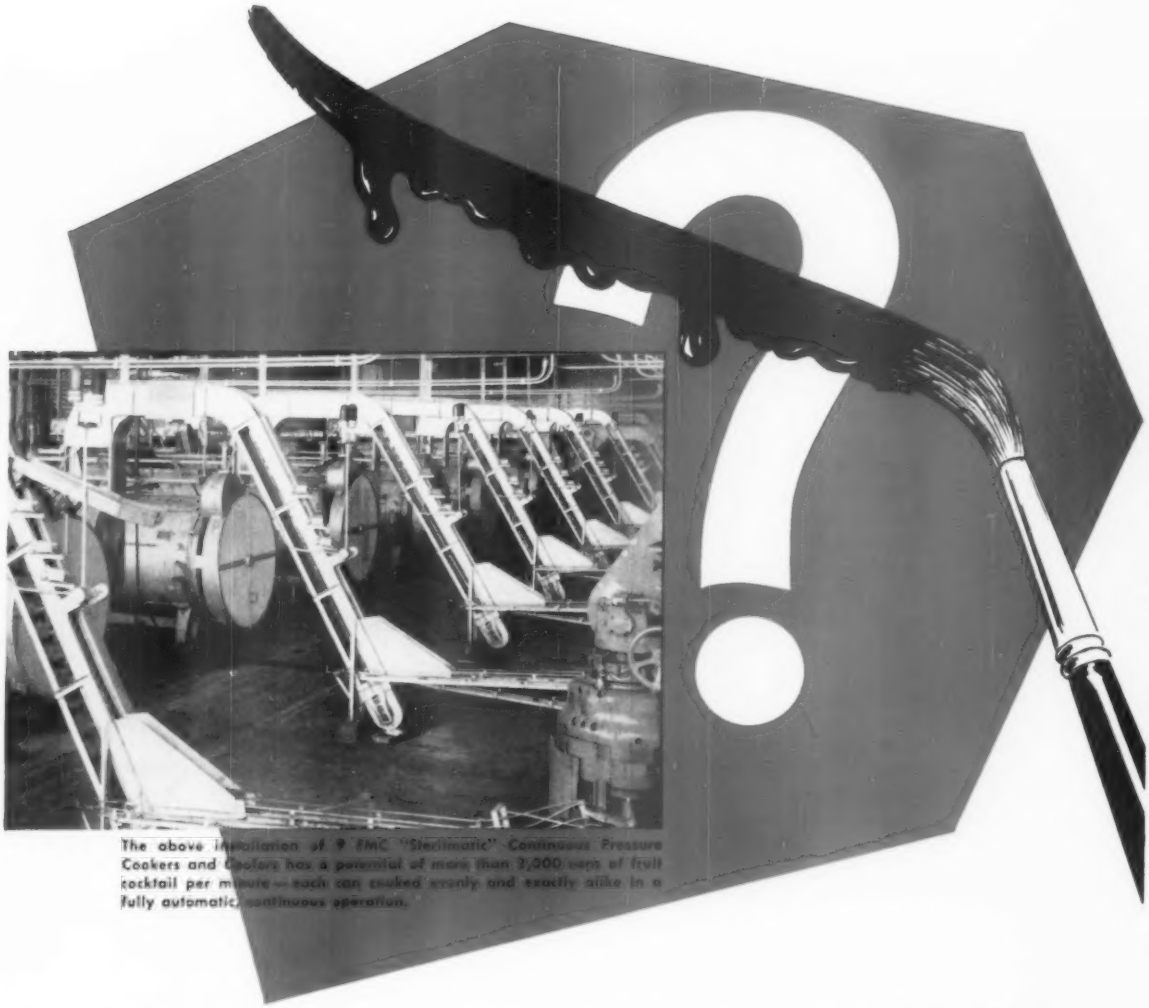
Research efforts are directed to foods of importance to Illinois agriculture such as milk and its products, soybean and corn oils, tomatoes, sweet corn, etc. Preservation of foods by thermal processing, freezing or drying, the packaging of foods for better preservation and basic studies on food spoilage organisms have all received attention.

Research. Recent and current research by graduate students and staff members embraces many products, food constituents, and techniques. Detailed studies on the dehydration of sweet corn, lima beans and chicken meat have been conducted. Improvements in the thermal processing of tomato juice and sweet corn and in making fruit preserves and jams are recent thesis subjects. Plastic films for the packaging of meats and heat processed foods are now being studied. Considerable attention is being devoted to the sporulation and germination requirements of food spoilage organisms as well as to factors which affect their thermal resistance. Work on fats, both animal and vegetable, has been directed not only to improve flavor stability but also to find out the relationship, if any, to atherosclerosis and the effect of heat and oxidation on nutritional value. More graduate research is concerned with the chemistry of fats than any other area. Milk proteins are being studied with respect to their heat stability, particularly as affected by high temperature short time treatments either to make sterile milk or ice cream mix. Fundamental studies on the electrophoretic properties of these proteins and changes occurring in the ripening of cheese are also being conducted. Problems involving the use of radiation to sterilize fruit, antibiotics in foods and ultrasonics applied to milk are being actively pursued.

Graduate research—getting down to some fundamentals.

Physical facilities of the Department are growing as the staff expands. One building devoted to dairy products contains a complete small creamery. Here all types of dairy products can be made and process research can be conducted. Research and classroom space are included. In part of another building, the food processing pilot plant equipment, including retorts, dryers and freezers, occupies 4000 sq. ft. Here also are a seminar room, student shop, taste panel room and kitchen as well as a laboratory for chemical work. Class laboratories for chemical and microbiological studies are in a third building. In September the microbiological work, now short of space for research, will move to a portion of the new Home Economics building about to be completed. Sometime in the future, it is

(Continued on page 42)



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(Continued from page 40)

hoped the department as a whole can be gathered under one roof.

FOOD TECHNOLOGISTS IN URGENT DEMAND

To date the enrollment in the food technology curriculum has not kept pace with the demand for food technologists. It is suspected that lack of knowledge among high school seniors about the possibilities of careers in this field has been largely responsible. Many students now in the curriculum have transferred to it in their sophomore or junior years after learning of this field while in college. A real problem exists in how best to present the opportunities and advantages to high school students. Engineering and the shortage of engineers have been so well advertised that the engineering curricula are full. The recent leaflet on careers by the Institute of Food Technologists is a good contribution. Further efforts in this direction are needed.

Food Technology at Illinois is looking forward with confidence in the belief that this Department can continue to prepare students for professional careers in the food industries. Whatever the changes in new processing methods, new machinery, or new food products may be, the food and dairy technologist will need to have training in the basic sciences. Research on the chemical and physical properties of food components and the biological aspects of food use and preservation will continue to be the basis for further advance. It is hoped that with continued assistance from both within and outside the University, this Department can efficiently use its present resources and make a greater contribution to the food industries and the science of Food Technology.

BOOKS . . .

FISH SAVING, by Charles L. Cutting. Leonard Hill Limited, London 1955.

It is not often that one finds a technical book that makes fascinating reading, that is well written and full of interesting factual information. Such a book is Cutting's "chronicle of the methods evolved by man down the ages for keeping fish in edible condition." It concentrates on "the techniques of preserving fish as food."

The chapter headings will give some notion of the scope of the book: Antiquity, Fish in Pre-Industrial Times, Salt Pickled Herring, Red Herrings, Bloaters, Pilchards and Salmon, The Rise of the British Herring Industry, White Fish Salting and Drying in Norway, Iceland, and Newfoundland, North Sea and Home Waters, The Canning of Fish, Distribution of Fresh Fish I (Live fishing, Trawling, Ice and Railways) and II (The Reign of Steam and Speed), The Development of Mildly Smoked Fish, Freezing of Fish, Fish Meal and Dehydration, The Future. There is an index of species of fish, of names and places, in addition to a general index.

This book is a storehouse of information on, among others, early fishing methods, curing of fish, literature references to fish and fishery terms. Interesting facts are also given about the history and early development of canning both in England and in the United States, following Appert's discovery and its practical application, and of the introduction of tinplate containers by Peter Durand in 1810 and of the sanitary can with a vent hole in 1823.

The book will be found to be worthwhile reading not only by fisheries technologists, but also by other fisheries workers and even the general reader who may be interested in the development of many of the currently available fishery products. There are a number of illustrations, including many in color.

LIONEL FARBER
San Francisco, California

PROCEEDING OF THE FIRST FOOD PHYSICS SYMPOSIUM (March 15-16, 1956) sponsored by the Southwest Research Institute and the Institute of Food Technologists. Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas.

This attractively reproduced document—179 pages in length, including numerous illustrations—records the eleven technical papers of the two-day session and the essential discussion. Among the topics covered are the analysis of liquids and solids by magnetic resonance absorption, vapor phase chromatography, physical methods used in the meat industry, in the measurement of food quality, in food processing, and in instrumentation. Ultrasonics and the potential role of nuclear reactors in food processing are additional topics presented. Session chairmen and speakers included: L. E. Clifcorn, H. Vagtborg, B. W. Beadle, W. J. Hamm, P. M. Erlandson, T. M. Shaw, K. P. Dimick, J. Corse, D. M. Doty, A. C. Shuman, I. Hlynka, K. H. Norris, E. W. Reid, Q. C. McKenna, R. J. Beeley, V. F. Hanson, and J. P. O'meara. M. S. P.

PROCEEDINGS OF THE SYMPOSIUM ON NUTRITIVE ASPECTS OF PRESERVED FOODS, Oct. 1954. Publication No. 115, Swedish Institute for Food Preservation Research, Göteborg, Sweden.

In April of this year the Proceedings of the Symposium on the Nutritive Aspects of Preserved Foods, held at the Swedish Institute for Food Preservation in Göteborg in October, 1954, were released. This Symposium was arranged by Dr. Georg Borgström under the auspices of the International Committee of Food Preservation Research (Comité International Permanent de la Conserve).

In his introductory talk Dr. Borgström pointed out that the objectives of the Symposium were:

"to give a survey of the nutritional development as it now appears and analyze trends and find out what might affect the future development of the food processing industry. The second aim is to point out some technical achievements which might, as we think, influence future activities in the field of nutritional research." Sixty-three participants were present representing Denmark, England, France, Germany, Holland, Norway, Sweden, Switzerland and the United States. Dr. Henri Cheftel gave the opening address in the name of

(Continued on page 44)

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(Continued from page 42)

M. Manaut, President du Comité International Permanent de la Conserve.

The papers presented were as follows:

Nutrition and Food Technology — G. Borgström (Sweden).

Recent Progress in the Field of Nutrition—R. A. Gortner, Jr. (U.S.A.).

The Necessity of the Use of Preserved Foods—K. Lang (Germany).

The Effect of Canning on the Nutritive Value of Canned Fruits and Vegetables—W. B. Adam (England).

The Significance of Peptides in Human Nutrition—O. Mellander (Sweden).

The Amino Acid Composition of Plant Protein—G. Ågren (Sweden).

The Effect of Heat on the Nutritive Value of Protein—H. D. Cremer (Germany).

The Nutritive Efficiency of Dehydrated Milk—K. Dürrenmatt (Switzerland).

The Protein Decomposition in Semi-Preserved Herring—F. Alm (Sweden).

On the Role of Histamine in Poisoning with Spoiled Fish—E. Geiger (U.S.A.).

The Nutritional Value of Fruit Juices—V. L. S. Charley (England).

Fruit Juice and Hospital Diets—R. Heupke (Germany).

The Use of Vitamin B_{12} in Food Products—N. Nielsen (Sweden).

Comparison of Non-Treated and Fried Fresh and Frozen Beef as to the Losses in Weight After Canning—O. Dahl (Sweden).

The Nutritional Effects of Rancid Fat—A Discussion —Borgström et al.

A Survey of Modern Nutritional Gerontological Problems—E. Eckerström (Sweden).

Dietetic Canned Food—L. E. Clifcorn (U.S.A.) (read by Borgström).

Achievements in the Field of Canned Baby Food and the Future Development in this Field—N. Abdon (Sweden).

The Control and Use of Chemical Aids in Food Processing—C. A. Frazer (England).

The Role of Preserved Foods in the Diet Regimens of Military Establishments — K. A. Delphin (Sweden).

The Proceedings include all of the papers except the one by Abdon on Canned Baby Food and the one by Clifcorn on Dietetic Canned Foods. The latter paper was published in the Journal of the American Dietetic Association, **29** (2), 116 (1953). The paper by Borgström was a broad and complete discussion of Nutrition and Food Technology, which followed by the papers of Gortner and Adam provided excellent information on the latest concepts of the role of specific nutrients in human nutrition and the effects of canning upon them. The subject of proteins was covered very completely in this Symposium. Of particular interest in the Proceedings is the paper by Cremer on the effect of heat on protein quality. The essential fatty acids in human nutrition were discussed capably by Dr. Söderhjelm followed by an excellent discussion of the nutritional effects of rancid fats. The other papers most adequately did justice to their titles.

Anyone interested in obtaining a copy of these Proceedings should write to Dr. Georg Borgström, Swedish Institute for Food Preservation Research, Göteborg Sweden and request SIK—Publication No. 115.

L. E. Clifcorn
Barrington, Illinois

The Chemical Constitution of Natural Fats, by T. P. Hilditch, 3rd Ed. Revised, 664 pp., John Wiley & Sons, Inc., New York, 1956. $16.00.

Hilditch has rendered another distinctive service to those whose interests bear directly or indirectly on fats and oils by revising this classic, first published in 1940. The present volume is the second revision and contains most of the relevant material available up to the end of 1954. An introductory chapter is followed by reviews of the component fatty acids in fats of aquatic flora and fauna (Chapter II), in fats of land animals (Chapter III), and in vegetable fats (Chapter IV). Chapter V contains a survey of methods, methods of computation, and theories of glyceride structure. Of particular interest is the author's discussion of the views which have been put forward from time to time in opposition to his own rule of "even distribution" of fatty acids in glycerides. Chapter VI reviews the available data on the composition of the glycerides of vegetable fats, and Chapter VII, those on animal fats.

Chapter VIII is entitled "Some Aspects of the Biosynthesis of Fats," and includes discussions of the biosynthesis of fats in plants and animals, a fairly lengthly resumé of possible mechanisms of the conversion of carbohydrates into fats, and one on the assimilation of fats by animals. It is unfortunate that there is no reference to the very important recent information concerning the role of coenzyme A in lipogenesis.

Finally, there are chapters on the constitution of the individual natural fatty acids (IX), synthetic glycerides, and naturally occurring fatty alcohols and acyl ethers of glycerol (X), and experimental techniques employed in the quantitative investigations of fats (XI). Five separate indices (general, individual fats and waxes, plant families, individual fatty acids, individual glycerides) make this volume extremely useful for reference purposes. Although the text is well documented, there is no author index.

The book does not contain reviews of the unsaponifiable components of fats and oils, hence the reader must look to other compendia for information on carotenoids, sterols, fat-soluble vitamins, etc. Nor will he find tables of physical and chemical characteristics such as melting points, iodine numbers, saponification values, etc. Such technological information is also available in other sources. But nowhere else will he find as complete a survey of the present information on the fatty acids and glycerides occurring in the natural fats. This will be a standard reference for some time.

Harold S. Olcott
Berkeley, California

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IFT ACTIONS AND REACTIONS...

ACTIONS OF THE COUNCIL[a] AT THE 16th ANNUAL MEETING ST. LOUIS, JUNE 10, 1956

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R. F. Cain, Oregon (Alt.)
J. G. Woodroof, Dixie
E. E. Burns, Texas (Alt.)
K. T. H. Farrer, Aust. No. and So. (Alt.)
L. F. Rutledge, Ind.

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M. K. Veldhuis, Fla.
R. Morse, N. Y.
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R. J. Garrard, Publisher
C. S. Lawrence, Exec. Secy.

Highlights of the Council Meeting, June 10, 1956, Dr. L. E. Clifcorn, presiding, are herewith presented. Since full details are available in the account of the meeting provided in mimeograph form by the Executive Secretary, the present report will summarize the key actions taken in regard to official reports of officers of the Institute, reports of the special committees, appointments, and other items of more than routine interest. Appendices include condensed versions of the reports on the financial condition of the Institute as of April 30, 1956, journal circulation, membership, and the condensed budget for 1956-57.

Dr. L. E. Clifcorn, President of IFT, called the meeting to order and asked Dr. Olsen to present the Treasurer's Report. It was moved, seconded and carried that this report be accepted. (See Appendix for condensed version of this report.)

The President stated with regret that Dr. Olsen would be unable to continue as Treasurer of the Institute and that the Executive Committee had, by unanimous action, nominated Mr. Ray B. Wakefield for appointment to the office of Treasurer for a period of one year. It was moved, seconded and carried that Mr. Ray B. Wakefield be appointed to the office of Treasurer of the Institute for a period of one year.

It was moved, seconded and carried that the Council extend to Dr. Olsen its sincere appreciation for his many years of devoted and untiring service to the Institute: on the Council, on the Executive Committee, on various other Committees, and for the past several years, as Treasurer of the Institute. It was further directed that a scroll or plaque recognizing in suitable language the excellent services of Dr. Olsen, be inscribed and presented to him by the Executive Committee under appropriate conditions to be indicated by the President.

Advertising. The Executive Committee having recommended the appointment of an Advertising Advisory Committee, it was moved, seconded and carried that the President appoint such a Committee.

The Committee will seek to promote a greater awareness on the part of the membership to the importance of Journal advertising to the individual member and to the financial stability of the Institute and will give assistance to the Institute in calling the attention of prospective advertisers to the advantages of reaching the IFT audience.

Career brochure and sound movie. The Secretary presented a report on the Career Brochure project as follows:

Original printing	5,000 copies
Second printing	70,074 copies
Third printing	10,000 copies
Total	85,074 copies

	Copies
Distribution to high schools, public and private (2 copies each)	60,000
Sold at cost to schools offering courses in Food Technology, Food Science or Food Engineering	7,000
One copy each to members of N.S.T.A.	10,000
Individual students, teachers and councilors	5,000
On hand	3,000

(Individual requests are still coming in at the rate of approximately 100 per week)

Total expenses to date		$12,640.95
Contributions received	$7,550.00	
To be received from sales to schools	875.00	8,425.00
Total cost of project to Institute		$ 4,215.95

Contributions are still being received and it is believed that a considerable portion of the net cost of this Brochure to the Institute will be recovered from subsequent contributions. This project was authorized by the Executive Committee and Council at the Mid-Year Meeting. It was moved, seconded and carried that the action of the Executive Committee be approved and that those involved be commended for the good work done in the production and distribution of this Brochure.

The Secretary also reported on his investigation of the possibility of producing a 16 mm. sound movie on Food Technology Career Guidance—such a film to be made available on loan basis to high schools throughout the country. He further stated that he would have sufficient data on this project to present definite recommendations to the Executive Committee at the Mid-Year Meeting.

(Continued on page 48)

[a] Present.

CONTINENTAL *Landmarks*

Periodic progress reports of interest and value to the food processing field

New airless hot-spray application of enamels gives 100% coverage to steel pail interiors

Perma-Linings are applied within the formed container. Portions of the solvents burst into a gas on leaving the nozzle tip to form the spray pattern, which gives complete, uniform coverage to entire inner surface.

Sprayed pails are subjected to increasing heat as they move through a new, specially-designed oven. Peak bakes exceeding 470° assure complete cure of Perma-Lining.

Shippers of jams, jellies, fountain syrups, ice cream toppings and other food products will have a particular interest in a recent cooperative development of Continental research men and industrial engineers. Utilizing their vast experience with the application of can linings, our men have found a way to hot-spray enamel linings within formed steel containers for 100% coverage. Even side and bottom seams get full, even protection.

The new technique is airless—that is, no compressed air is used to atomize the enamel. Instead, hydraulic pressure is employed in connection with heat. The solvents burst into a gas when released to atmospheric pressure. By elimination of turbulence in the spray pattern, a heavier film thickness of maximum uniformity is achieved. Quick baking at steadily increasing temperatures effects a complete cure.

Continental's line of steel pails is admirably adapted to this new process. Bail ears are welded in place—not riveted—to prevent crevices at this point. Pail structure at the bottom has been altered to allow better inside enamel fillet at double-seam chime opening. Perma-Lined steel containers are made in 2- through 12-gallon sizes in open top, lug-cover style, and in 5-gallon closed-head drum style.

Linings can be developed to meet every food-protecting problem. Now in use are straight and modified phenolics, oleoresinous, vinyl resin and epoxied resins, applied in single or dual coats.

CONTINENTAL CAN COMPANY

EASTERN DIVISION: 100 E. 42nd St., New York 17
CENTRAL DIVISION: 135 So. La Salle St., Chicago 3
PACIFIC DIVISION: Russ Building, San Francisco 4

TAILOR-MADE PACKAGE SERVICE

(Continued from page 46)

Annual meeting sites. The Executive Secretary called attention to the fact that while New York City had been selected for the site of the 1961 Meeting, there had been no definite action on the part of the Institute confirming this selection. It was moved, seconded and carried that New York City be designated as the meeting place for the 1961 Meeting and that the Statler Hotel be approved as the headquarters hotel.

A delegation from Florida, consisting of Messrs. O'Brien, Roy and Veldhuis extended a formal invitation to the Institute to hold its 1962 Annual Meeting at Miami Beach. Data pertaining to facilities, etc., were presented and were considered by the Council. It was moved, seconded and carried that the Council looks with favor upon a Meeting in 1962 at Miami Beach and that this matter again be considered at the Mid-Year Meeting of the Executive Committee.

There was some discussion as to the desirability of selecting several permanent meeting sites. Mr. Strasburger of the Maryland Section stated that his Section looked with disfavor on any permanent site or sites and that it was considered more desirable to continue the present system. It appeared after a general discussion that these views were held by a considerable majority of the Councilors and no formal action was taken on the matter.

Publications. Mr. Wakefield presented the report of the Publications Committee and pointed out that the Committee was happy to note that despite a considerable increase in subscription rates for FOOD RESEARCH, the circulation of that journal had increased rather than decreased which some had feared would happen. Mr. Wakefield offered the following amendment to his report:

> The Journals, being the life blood of our organization, it is very important to maintain their high level of quality. The major share of the cost of supporting these Journals comes from advertising income. As the result of good advertising income in recent years, we have been able to build up a substantial reserve for the Institute. The possibility always exists that in the future, due to changes in economic conditions, advertising income could be sharply reduced. The Committee, therefore, recommends that the Institute go on record that it is their intent and policy that such accumulated reserves be used during periods of an emergency to maintain the standard of our publications.

It was moved, seconded and carried that the Council accept the report as amended and that this acceptance indicates the Council's approval of the policy recommended in the amendment.

President-Elect Garnatz presented the following:

> Clarification of policy with respect to the publication of a monograph. In connection with the 1957 Meeting in Pittsburgh, unless we are told we are off-base, we are proceeding with plans for staging a symposium on Taste Testing and Consumer Acceptance Testing and in conjunction with it are assuming that the material thus presented will serve at least as a nucleus for a monograph to be published by the IFT under an appropriate title.

During the discussion the Chicago Section Councilors stated that the Chicago Section viewed with alarm the proposal to publish a monograph series and objected in principle to monographs. It was moved, seconded and carried that the Institute try out the idea of the publication of a monograph provided that a qualified committee has previously judged the worthwhileness of the output of the symposium papers and/or discussion.

Dr. Peterson presented the Editor's Annual Report and reviewed briefly the status of manuscript backlogs for both Journals. It was moved, seconded and carried that the Editor's Report be accepted with commendation to Dr. and Mrs. Peterson.

Committee reports. The report of the Committee on Qualifications was received. This report contained a request for an interpretation of the Constitution with respect to when an individual may be considered qualified for Student Membership. It was moved, seconded and carried that the Constitution be interpreted as requiring that to qualify for Student Membership an individual must be a full-time student.

The report of the Committee on History was presented and received with thanks.

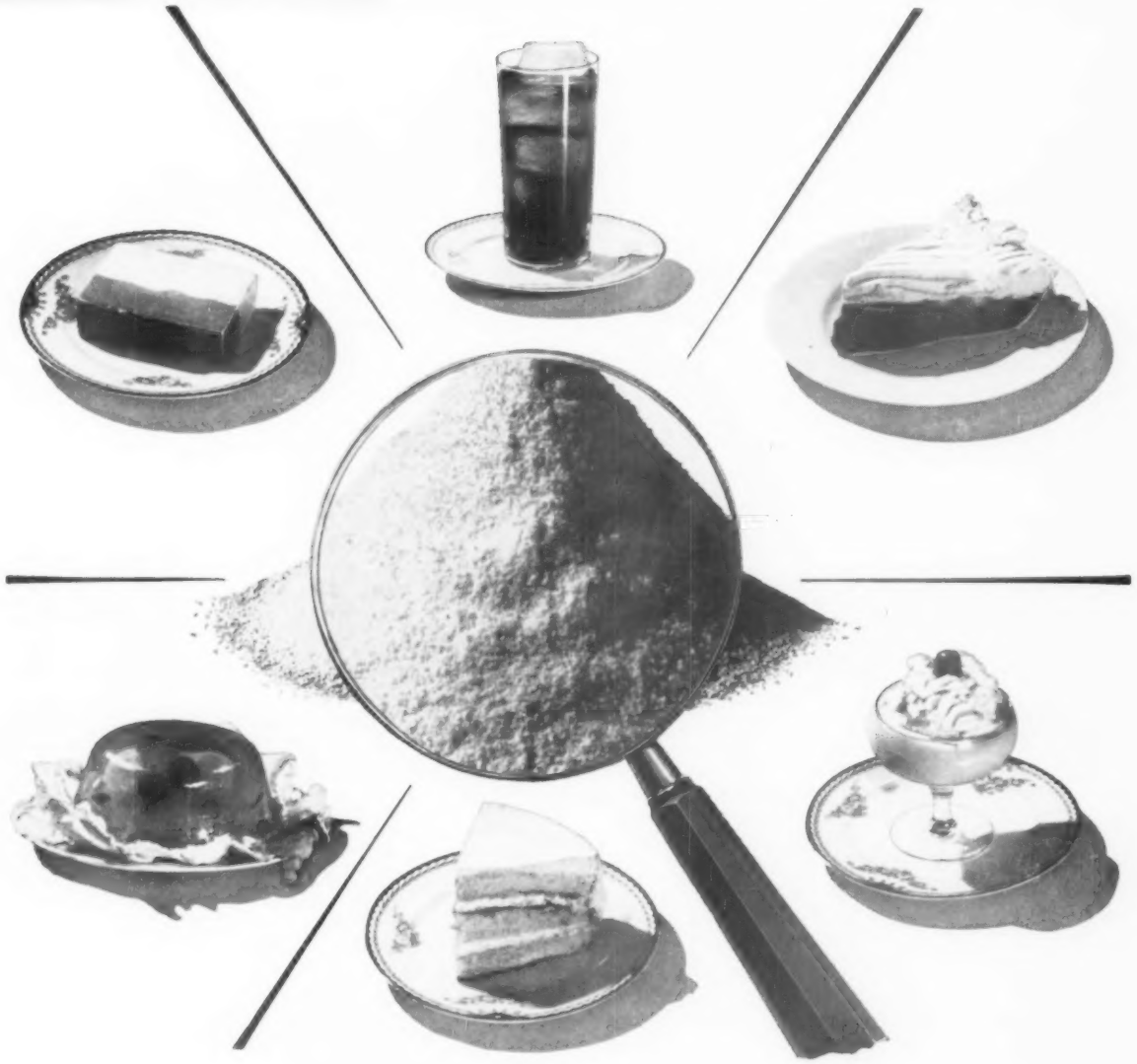
The Council next heard the report of the Committee on Constitution and By-Laws. This Committee received during the year a suggestion that consideration be given to a change in the Constitution increasing the number of Councilors-at-Large from ten to twelve, and increasing the term of tenure from two to three years. This suggestion was carefully weighed by the Committee and it is the considered opinion of each of the members that such a change would be in the best interests of the Institute for the reasons enumerated herewith.

At least one year is required for a member of the Council to become acquainted with the manner in which the Council functions. Councilors-at-Large are not eligible for re-election after completing their two-year term, and the value of their experience is soon lost. By increasing the number of Councilors-at-Large to twelve, four to be elected annually, and lengthening the term to three years, the Council would be assured two-thirds of the Councilors in any given year would be experienced and should be able to serve the Institute more effectively.

The Committee proposed an amendment to the Constitution, incorporating the suggested changes and also included in the amendment the mechanics for an orderly switch from the present system. The Committee recommended favorable action on this amendment.

The Committee in reviewing the By-Laws found in some instances contradictions with the Constitution. This was noted in some sections dealing with Committee appointments. With particular reference to Article XI of the Constitution (Committees) the President-Elect is required to appoint certain committees whereas in practice he has rarely been able to make

(Continued on page 50)



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Givaudan Flavors Inc.

330 West 42nd Street, New York 36, New York

(Continued from page 48)

such appointments until after he has assumed the presidency. Certain committees are called for whereas others equally as necessary are not mentioned.

Since changes in the Constitution, however desirable, are cumbersome and costly to make inasmuch as they require action by the entire membership, the Committee on Constitution and By-Laws recommended that Article XI and XII, Section 3, of the Constitution be revised so that changes in committee structure may be made by action of the Council through enactment of By-Laws. A proposed revision was presented.

The Committee has been impressed by the difficulty in providing mechanics for implementing changes in the Constitution. For example, it is necessary to provide the mechanics for the interim period in the transition from ten Councilors-at-Large to the proposed twelve whereas it would be preferable for the Council to have the authority to solve such mechanical problems. The Commitee, therefore, recommended that the entire Constitution be reviewed and revised to provide the necessary safeguards to the Institute but give sufficient flexibility that the Constitution will not be unnecessarily encumbered with obsolete provisions.

With reference to By-Laws, the Committee recommended changes to include a new and separate section on committees; the transfer of certain portions of Article IX, Section 6, to Article VII, Section 4, which covers rules governing presentation of papers; and the deleting of material dealing with policy matters.

It was the conviction of the Committee that the Institute Program Policy should be set forth in a manual on Policy and should not be spelled out in the By-Laws.

It was moved, seconded and carried that the changes recommended be made. The Council expressed its thanks and appreciation for the very excellent and detailed work done by the Committee on Constitution and By-Laws.

It was moved, seconded and carried that the following reports of Institute Committees be received and that the thanks of the Council be extended to the Committees:

Committee on Education
Committee on Qualifications
Public Relations Committee
Committee on Chemicals in Foods
Committee on Taste Testing and Consumer Preference
Committee on Citrus Products
Committee on Frozen Foods
Committee on Pectin Standardization

(To the extent possible these reports will be published during the year in FOOD TECHNOLOGY.)

The Council received the report of the Committee on Awards together with the recommendations of the Executive Committee with respect to this report.

It was moved, seconded and carried that the Council approve the recommendations made by the Executive Committee concerning the report of the Awards Committee.

Concluding actions. The following items had been submitted by the Northern California Regional Section for consideration by the Executive Committee and Council:

(a) Discussion of means of providing more time for the introduction of new business at Council Meetings.

(b) Discussion of the practice by which members of the Council are requested to vote on a number of separate propositions by a single vote.

(c) A review of the standards for qualification of national members.

It was moved, seconded and carried that these matters should be referred to the incoming President for discussion with the Section to ascertain what it is that proves to be objectionable and make an attempt to reach an agreement satisfactory to all concerned.

The matter of mailings to overseas members was discussed and the Council recognizes the merit of the complaint of some overseas members regarding the long delay in the receipt of surface mail, but the Council feels that it is impossible to handle all of this correspondence and literature by air mail unless the dues of overseas members are raised sufficiently to cover the additional administrative cost.

It was moved, seconded and carried that the following individuals be appointed to the positions indicated for a period of one (1) year:

Martin S. Peterson, Editor of Institute Journals
Arthur N. Prater, Assistant Treasurer
Charles S. Lawrence, Executive Secretary
Marian A. Gilchrist, Assistant Executive Secretary.

It was pointed out that a vacancy existed in the Councilors-at-Large whose terms expire in June 1957, one of these Councilors, Dr. Emil M. Mrak, having been elected to the office of President-Elect. Aksel G. Olsen was nominated to fill this vacancy. It was moved, seconded and carried that nominations be closed and that Aksel G. Olsen be unanimously elected.

It was moved, seconded and carried that the officers of the Institute be commended for the excellent progress made during the past year.

Appendices

I. Financial Statement as of April 30, 1956

ASSETS

Cash in Bank	$ 61,443.80
Accounts Receivable	2,254.25
Furniture and Equipment	3,539.85
U. S. Treasury 90 day Notes (at cost)	60,558.00
Prepaid Premiums	515.14
Accounts Receivable Loans to Sections	3,000.00
	$131,311.04

LIABILITIES

Prepaid Exhibit Fees	$ 22,528.49
Reserve for Depreciation F. & E.	3,014.41
Unearned Subscriptions	13,644.00
Funds held in Trust on Fellowships	4,400.00

(Continued on page 52)

ATLAS Food Facts

FOOD INDUSTRY DEPARTMENT
CHEMICALS DIVISION

ATLAS POWDER COMPANY
WILMINGTON 99, DELAWARE

SORBITOL PROTECTS FOOD FLAVOR AND SHELF LIFE, HELPS SOLVE MANY FOOD FORMULATING PROBLEMS

Significant advances in food processing are being achieved through Atlas sorbitol, used principally as a conditioning agent to retain softness and moisture and improve texture, taste, and keeping qualities of many types of food.

IN CANDY MAKING. Sorbitol modifies the crystal structure of mixed sugar systems . . . keeping candies soft and tasty longer. Sorbitol also helps stabilize moisture content under varying temperature and humidity conditions . . . so candies remain "just right"—not too soggy in humid weather; nor too hard in dry weather. In general, sorbitol works best in aerated candies having a relatively high moisture content.

Works as a player on a team. A concentrated sorbitol solution will "set up" or crystallize when subjected to cold or low humidity temperatures. But when added to other candy ingredients, sorbitol acts like a player on a team . . . working with the mixed sugar systems to maintain softness and palatability to a much greater degree than can be obtained without sorbitol.

IN PROTEIN WHIPS. Viscosity and specific gravity of an aqueous sorbitol solution of given concentration are both slightly lower than a sucrose solution of the same concentration. One might speculate which of these characteristics explains why sorbitol solutions produce more stable and lighter whips than sucrose solutions. Protein whips having an unusual low range of density with good stability are produced using sorbitol.

IN DIETETIC SOFT DRINKS sorbitol is used for flavor dispersion and bodying purposes in low calorie soft drinks . . . improving "mouth feel" and adding new taste appeal. Only a small amount of sorbitol . . . 1 to 1.5% of the finished beverage . . . can make a big difference in the consumer acceptance of the soft drink. Call or write Atlas for more facts on the remarkable properties of sorbitol and how they can be applied to advantage in your product.

WHAT IS SORBITOL?

Chemically, sorbitol is a six-carbon, straight-chain hexahydric alcohol. It is found naturally in a wide variety of fruits, berries, and plants; but, it is produced commercially by treating the common sugars—cane, beet, or corn—with hydrogen.

In the pure form, sorbitol is a white, odorless crystalline powder. Usually supplied as a 70% aqueous solution, SORBO®, it is also available in powder and pellet form.

Sorbitol has a mildly sweet cool pleasant taste which blends well with other food ingredients.

Not subject to seasonal fluctuations in price or supply, sorbitol is made from an inexhaustible raw material—sugar; and is not a by-product; so production is not limited by the demand for an unrelated primary product. Through war and inflation, its price has been on a steadily downward trend for 15 years.

(Continued from page 50)

Advance Payment Australia Northern Section	34.40
Net Operating Capital	87,689.74
	$131,311.04

II. Membership:

TOTAL PAID MEMBERS, May 1, 1955		4,157
LOSSES: Deaths 16—Resignations 77	93	
Dropped for non-payment	341	
Total Losses		434
BALANCE		3,723
GAINS: Reinstatements 77—New Members elected 622		699
TOTAL PAID MEMBERS, APRIL 30, 1956		4,422
Net Gain for Fiscal Year '55-'56		265
Net Gain for Fiscal Year '54-'55		221
Net Gain for Fiscal Year '53-'54		293

	1953	1954	1955	1956	Gain
Student Members	180	175	196	216	20

CLASS AND GEOGRAPHICAL DISTRIBUTION OF MEMBERS

	United States†	Canada	Other Foreign	Total
Professional Members	2,638	80	225*	2,943
Members	1,150	38	75**	1,263
Students	211		5***	216
TOTAL	3,999	118	305	4,422

†U. S. and Territories—Includes Alaska, Hawaii, Panama Canal Zone, Puerto Rico, Guam.

*—121 of these are in Australia
**— 31 of these are in Australia
***— 3 of these are in Australia

III. Journal Operations

	Food Technology	Food Research
Total pages used	1,276	808
Total Copies produced	68,318	13,198
Gross Manufacturing Cost	$55,497.17	$14,425.98
Received from manuscript subsidies	161.13	769.61
Net manufacturing costs	55,336.04	13,656.37
Average mfg. cost per issue page	43.50	17.85
Average mfg. cost per copy	.812	1.09

JOURNAL CIRCULATION:

FOOD TECHNOLOGY

Member Subscribers	4,422	
Non-Member Subscribers	1,018	
TOTAL PAID CIRCULATION		5,440
Advertisers, agencies, representatives, complimentary and exchange		191
TOTAL CIRCULATION		5,631
Net Gain in paid circulation for the year	355	

FOOD RESEARCH

Member Subscribers	648	
Non-Member Subscribers	1,390	
TOTAL PAID CIRCULATION		2,038
Advertisers, agencies, complimentary and exchange		26
TOTAL CIRCULATION		2,064
Net gain in paid circulation for the year	69	

IV. Condensed Budget (1956-1957)

FOOD TECHNOLOGY:		
Income:		
Member Subscriptions (50% membership dues)	$16,042.50	
Non-Member Subscriptions	9,162.00	
Advertising Income	73,950.00	
TOTAL		$99,154.50
Expense:		
Printing, mailing, circulation and advertising expense	$72,980.00	
Editorial Office	7,200.00	
Publishing, accounting and administrative exp. including insurance, taxes, etc.	11,795.00	
TOTAL		$91,975.00
ESTIMATED SURPLUS		$ 7,179.50
FOOD RESEARCH:		
Income:		
Member Subscriptions	$ 4,860.00	
Non-Member Subscriptions	11,815.00	
Advertising Income	512.00	
TOTAL		$17,187.00
Expense:		
Printing, mailing, circulation and advertising expense	$14,132.00	
Publishing, accounting and administrative expense	1,685.00	
Editorial Office	3,600.00	
TOTAL		$19,417.00
ESTIMATED DEFICIT	$ 2,230.00	
INSTITUTE OPERATIONS:		
Income:		
50% of Membership Dues	$16,042.50	
Income from Annual Meeting	12,000.00	
Sale of Back Issues of Publications	700.00	
Interest Earned	1,000.00	
Miscellaneous Receipts	350.00	
TOTAL		$30,092.50
Expense:		
Rent, Staty., Tele., Taxes, Off. Equip., Audits, Bonds, Insurance and Travel	$ 8,520.00	
Exec., Admin., and Accounting Salaries	13,500.00	
President's Office	2,900.00	
IFT News and Publicity Program	750.00	
Membership Certificates	700.00	
TOTAL		$26,370.00
ESTIMATED SURPLUS		$ 3,722.50

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WORLD'S LARGEST SUPPLIERS OF VANILLIN

AWARDS AND HONORS . . .

DR. LLOYD A. HALL NAMED FOR HONOR SCROLL AWARD OF CHICAGO CHAPTER OF INSTITUTE OF CHEMISTS

Dr. Lloyd A. Hall has been selected as the recipient of the Honor Scroll awarded annually by the Chicago Chapter of the Institute of Chemists. The presentation will be made at a dinner to be held at the Furniture Club, Chicago, on October 5th. The title of Dr. Hall's acceptance address will be "INVESTMENTS IN TOMORROW."

A Charter Member of the Institute of Food Technologists, Dr. Hall has been prominent in Institute affairs for many years, having served on various important committees and on the Council and the Executive Committee of the Institute. In addition to his professional interests, Dr. Hall has been active in civic affairs and recently was signally honored by Mayor Daley of Chicago who appointed him to Chicago's and the Nation's first official Community Conservation Council. Appointed to the Council with Dr. Hall were ten other prominent Chicago residents, including Dr. Louis Mann, Mr. Gustavus Swift, Jr., and Mrs. Charles Schwartz.

Dr. Hall, a past Chairman of the Chapter, was chosen for the Award "because of his intense interest and influence in promoting truly professional attitudes and constructive actions in the profession of chemistry, his enthusiasm and positive direction in guiding and promoting the professional growth of young chemists, his very active participation and recognized leadership in both civic and technical organizations, and because of his outstanding technological accomplishments in industry."

DAVE EOLKIN WINS MONSANTO AWARD FOR BEST PRESENTED IFT ANNUAL MEETING PAPER

Designed to furnish an incentive for effective presentation of annual meeting papers, the Monsanto Award is a feature of IFT annual meetings. This year's Award has been given to Dave Eolkin for his report on the plastometer—a new development in continuous recording and controlled consistometers. As the name implies the instrument indicates, controls, and records the consistency of foods. Its special application is to purees.

Mr. Eolkin, who is with the Gerber Products Company of Oakland, California, presented his paper on June 12 before the Food Engineering Session at the 16th annual meeting of IFT in St. Louis. In organization of material and in illustrative adjuncts, Mr. Eolkin's paper was outstanding. The delivery of the paper won equal acclaim from the judges. The Monsanto Award consists of a bronze plaque and an honorarium of $200.

MASTERS AND DOCTORS DEGREES IN FOOD TECHNOLOGY AND RELATED SUBJECTS

A further installment of degree winners in the field of Food Technology and related subjects is herewith presented.

UNIVERSITY OF MINNESOTA, ST. PAUL, MINNESOTA

Name	*Degree*	*Title of Thesis*
Anderson, Charles A.	Ph.D.	The heat denaturation of beta-lactoglobulin and alpha-lactoalbumin
Ciagne, Raymond	M.S.	Investigations of some chemical and bacterial properties of several dairy plant water supplies
Fuller, Robert Arthur	Ph.D.	Interspecies complex formation in denatured protein mixtures. Some observations on the formation of intermolecular hydrogen and disulfide bonds during the aggregation accompanying protein denaturation
Green, Velvl William	Ph.D.	The effect of heat treatment of milk and milk powder on the development and activity of lactic acid cultures (cheese starters)
Grosh, Gordon Michael	M.S.	The effect of oxidized and unoxidized fatty acids on the stability of flours during storage
Hill, Robert Mathew	Ph.D.	Some physical properties of beta-lactoglobulin
Holme, John	Ph.D.	Studies on the physical nature of gliadin
Kuramoto, Simpey	Ph.D.	The application of the Tiselius-claesson interferometric adsorption analysis apparatus to *P. roqueforti* lipase studies on butterfat
Mayou, Joseph L.	M.S.	Some factors affecting CO_2 production by lactic starters
Mizuno, William George	Ph.D.	A study of the formation of acetoin by mixed lactic streptococci and leuconostoc
Nielsen, Arthur J.	M.S.	Changes in bacterial counts and flavor of dry milks, concentrated milk and dry ice cream mix before and after recombination by various means and storage at low temperatures
Peterson, Anne M.	M.S.	Studies on the inhibition of certain molds by lack of oxygen and dehydrogenase activity of wheat as a measure of viability
Wada, Shohachi	M.S.	Studies pertaining to the toxicity of trichloroethylene-extracted soybean oil meal

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Top accuracy refractometry in seconds!

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FASTEST, TOP ACCURACY READINGS! New instant-reading precision scale, graduated directly to .0005. Quick, easy estimates to .0001.

ASSURES FULL-WORKING-DAY COMFORT! Eyepiece at convenient height and angle for relaxed sitting-position observation; DUO-SPEED control knob and line-scale switch in low position for hand-at-rest operation.

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FOOD INDUSTRY TOPICS . . .

. . . by Norb Leinen

. . . ***in the public interest***

Despite the fact that the economies of principal spice countries in the Far East are in a turmoil and good spices have become increasingly difficult to obtain, quality spices are still available, reports Mr. Craig Fitzpatrick, vice president of Knickerbocker Spice Mills, New York City, recently returned from a 26,000-mile trip through the Orient. He pointed out Indonesia's situation, where the commodity market is secondary to the fluctuations of currency exchange. "Unless stimulated to supply top quality spices," he said, "suppliers find it easy to lose interest in that direction, and yield to the attractive inducements of other higher profit commodities such as rubber, rice, tea, and coffee. It is also easy for them to sell what spices they do have in other less particular world markets." The most effective remedy, as the situation in the Orient now stands, according to Mr. Fitzpatrick, is for food processors to realize that spices are not the place to cut corners on a food product. "Generally, spices amount to less than one percent of total product cost—no more than the normal cash discount on other purchases. The price range of various grades is hardly enough to affect the cost of the product, yet the quality difference between the various grades can definitely affect its taste and, ultimately, its sale," he pointed out.

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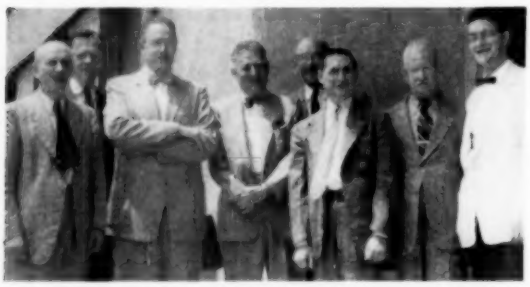

Some of the staff and guest lecturers who participated in the special summer program on "Perspectives in Food Technology" at the Massachusetts Institute of Technology were, left to right: Dr. Chas. N. Frey, lecturer, Department of Food Technology, MIT; Mr. F. Leslie Hart, in charge, Boston office FDA; Prof. Bernard E. Proctor, head, Department of Food Technology, MIT, and in charge of the special summer program; Dr. Arnold J. Lehman, chief, Division of Pharmacology, FDA; Mr. Wm. V. Hudson, vice president, Gerber Products Company, and president, National Canners Assn.; Prof. John T. R. Nickerson, Department of Food Technology, MIT; Dr. Samuel C. Prescott, dean emeritus, MIT; and Prof. Samuel A. Goldblith, Department of Food Technology, MIT.

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A graduate evening course in food engineering will be offered by the Department of Chemical Engineering of the City College of New York during the 1956-57 academic year. Subjects will include colloid chemistry and surface phenomena, unit operations as applied to food engineering problems, flavorology, and statistical methods in food research. City College is located at Convent Avenue and 139th St., New York 31, N. Y.

An informal committee composed of representatives of manufacturers of more than 90% of the certified food colors produced in this country recently announced endorsement of recommendations made by an advisory committee appointed by The National Academy of Sciences at the request of the Food and Drug Administration to review the adequacy of the research program on food colors now being conducted by FDA. The industry group stated it was gratified that the Academy committee had felt, as was stated in the committee's report, "compelled to indicate that certification of a compound as 'harmless and suitable for use' in foods, drugs, and cosmetics . . . is unrealistic unless the level of use is specified." The legal question as to whether or not the present law requires the Administration to consider quantity in normal use in certifying synthetic colors for human consumption is currently before the Federal courts. An industry spokesman pointed out that the manufacturers had some time ago voluntarily imposed limitations on the use of their products by adopting appropriate labels for the guidance of food processors.

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Opportunities for research in a number of different fields of interest are offered at Southern Utilization Research Branch of the Agricultural Research Service, USDA. Positions range from openings for the highly trained scientist, at a startling salary of $8,990 per year, to a few for scientific aids, beginning at $3,175 per year, and are graded under Federal Civil Service in accordance with training and experience. Chemists specializing in organic, physical, or analytical chemistry or biochemistry are needed; also physicists, cotton technologists, and chemical, textile, and mechanical engineers. The latter would work on development of cotton processing machinery. Application should be made through the U. S. Civil Service Commission, Eighth Civil Service Region, 1114 Commerce St., Dallas, Texas. Further details regarding career opportunities for scientists at the Southern Branch may be obtained by writing Dr. C. H. Fisher, chief of the Southern Utilization Branch, 1100 Robt. E. Lee Blvd., New Orleans 19, La.

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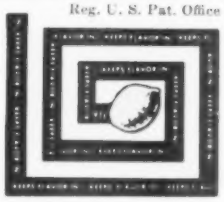
In view of adjustments made by the nation's livestock growers and feeders in their production and marketing operations, it appears that no emergency promotion campaigns are needed for any of the meats in the immediate future. That was the opinion expressed by livestock grower and feeder representatives at the meeting of the National Meat Promotion Committee in Chicago, June 23. It was recommended that retailers cooperate to the same degree as last year, but that their promotional and advertising activities be spread out over a longer period. Last year, retailers and packers spent $100,000,000 in meat ad-

(Continued on page 58)

FACT SHEET ON
ENTRAPPED POWDERED FLAVORS

Reg. U. S. Pat. Office



Florasynth being one of the first companies to manufacture powdered flavoring materials, we list below descriptive details of what we feel to be the finest type of New Entrapped Powdered Flavors. These New Entrapped Powders feature (1) as high as 50% oil content by weight. (2) Instantly dispersable. (3) Non-hygroscopic. (4) Extremely economical. Shelf life studies have indicated excellent results.

ENTRAPPED POWDERED FLAVORS

Manufactured and designed for use in Powdered Drinks, Gelatin Desserts, Cake Mixes, Pie Fillings, Puddings, Beverage Bases, Pharmaceutical Products, and wherever dry flavors can be used to good advantage.

Orange
Lemon
Lemon & Lime
Imitation Raspberry
Imitation Strawberry
Imitation Cherry
Root Beer
Cola Type
Imitation Grape
Imitation Pineapple
Imitation Banana
Imitation Maple

Vanilla, Pure & Imitation — Other Entrapped Flavors Developed on Request.

Suggested uses per 100 lbs.:

Gelatin Dessert	3 to 4 oz.
Cake Mixes	4 to 6 oz.
Puddings	3 to 4 oz.
Pharmaceuticals (such as aspirin)	2 to 4 oz.
Powdered Drinks (without sugar)	1 to 1½ lbs.

(1 oz. makes 2 qts. finished beverage)

TRADE PURITY MARK FLORASYNTH UNIFORMITY

ENTRAPPED POWDERED CLOUDINOL

Available for the first time to the beverage industry, a Dry Cloud. Two pounds when dissolved in water to one gallon will produce one gallon of Standard Cloud Solution of which one ounce per gallon of Syrup will produce an excellent suspension in the finished product. Excellent product for dry mixed beverages.

ENTRAPPED POWDERED CLOUDY FLAVORS

After years of research our Flavor Specialists have now developed Powdered Cloudy Flavors which will produce on dilution a finished beverage simulating fresh juice both in appearance and flavor. They are uniform powders which will not separate on dilution, will give a perfect Cloud and will not form a ring in the finished beverage.

Cloudy Orange
Cloudy Lemon
Cloudy Lime
Cloudy Lemon-Lime

Suggested Uses:

Syrups	½ oz. per gal.
Lemonade Mix	6 to 8 oz. per 100 lbs.
Lemon Bar Mix	6 to 8 oz. per 100 lbs.
Powdered Drinks (without sugar)	1½ to 2 lbs. per 100 lb. Mix

(1 oz. makes 2 qts. finished beverage)

Florasynth **LABORATORIES, INC.**

EXECUTIVE OFFICES: **900 VAN NEST AVE.,** (BOX 12) **NEW YORK 62, N. Y.** • CHICAGO 6 • LOS ANGELES 21

Cincinnati 2 • Detroit • Dallas • Memphis • New Orleans 12 • St. Louis 2 • San Francisco • San Bernardino

Florasynth Labs. (Canada Ltd.) • Montreal, Toronto, Vancouver, Winnipeg • Agts. & Dist. in Mexico: COMSOLMEX S.A. Mexico 11, D.F.

Consult our Research Laboratories on your Problems

(Continued from page 56)

vertising. This was in addition to the gigantic promotion and educational activities conducted by many groups and associations of the different segments of the livestock and meat industry, as well as through the service organization of the entire industry, the National Live Stock and Meat Board. Another meeting of the committee will be held in September or October for a further look at the meat production situation.

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A warning that motorists getting ready to make extended trips should plan their itinerary so as to permit frequent "coffee breaks" or other stops was issued by Mr. Gerald Phelan, manager of the Greater Detroit Safety Council. Figures released by the Council show that non-collision accidents, such as running off the road, are the largest single cause of highway deaths, accounting for more than one-third of fatalities. The Council suggests motorists follow these common-sense rules: 1) Don't make driving an endurance contest. Never drive more than 8 or 9 hours a day. 2) Stop every 2 hours or 100 miles, get out of the car, have a cup of coffee and a snack. 3) Be sure there is plenty of fresh air in the car. 4) Talk with other passengers, or, if alone, listen to the radio. 5) If drowsiness persists, let someone else drive; or pull off the road, lock the doors, and take a nap.

. . . *things new under the sun*

A new mono- and diglyceride emulsifier for frozen dairy products is being introduced to ice cream and mix manufacturers by Atlas Powder Co., Wilmington 99, Del., according to a joint announcement by the Food Industry Department of Atlas and R. G. Moench & Co., Inc., 89 Terminal Ave., Clark, N. J., distributors of Atlas emulsifiers to industry. Atlas' new product is an improved version of the well-known Atmos 150, and according to the announcement is equal or superior to all presently available "mono-type" emulsifiers in the 5 important qualities of dryness, body, texture, whipping time, and overrun. The product has been thoroughly tested in laboratories, and evaluated in commercial production at producing ice cream plants. Results of these tests as well as other properties and specifications of Atmos 150 are described in a product information bulletin available by writing either company.

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Du Pont "Cel-O-Seal" cellulose bands are now available in larger sizes, including diameters of 102 millimeters (approx. 4.02"). The former maximum size was 92 millimeters. The production change was indicated by the demand for larger sizes in the food and drug trade and the increasing use of "Cel-O-Seal" bands for coupling units for sampling or multiple packaging.

Du Pont also announces that facilities for coating "Mylar" polyester film to permit wider application in packaging and industrial fields will be installed at the firm's Circleville, O., plant. Construction is to start in September, and the coating equipment is to be ready for operation in the late summer of 1957. Until then coated "Mylar" will be available only in experimental quantities for developmental purposes.

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A completely new line of compound microscopes—MICROSTAR—has been announced by American Optical, Instrument Division, Buffalo 15, N. Y. Offering many possibilities for industrial applications, the basic design, unique in American microscope manufacture, features interchangeable and reversible inclined monocular, binocular, and trinocular bodies. The stage and specimen are focusable to the objective by low-positioned coarse and fine adjustments—body tube height and eye level remain constant. Variable autofocus minimizes possibility of damage to objective and specimen. Both left-hand and right-hand mechanical stages are available. All major adjustments are located in substage zone for ease of manipulation. Durable dove-gray Epoxy finish complements the advanced styling of these instruments.

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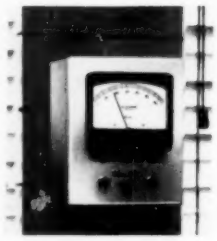
New Sparton **remote proportioning control system** offers a high degree of flexibility in meeting remote process supervision problems. Over one circuit, it both controls pilot proportioning operations and continuously monitors changes produced. The system features package "building block" construction which can be installed by the average plant electrician. As control requirements change or increase, units can be added without extensive modification. Adaptable to a variety of needs, the control system is available with or without transducers for telemetering such functions as pressure, flow, water level, pH factor, power, speed, phase shift, position, electrical quantities. It may be used in conjunction with existing operators or can be supplied complete with reversing motors and pilot operators up to several horsepower. Over-all accuracy of the metering system is guaranteed to better than 2 percent. Wall-mounted and switchboard-mounted units are available for tying in with existing facilities. Write Sparton Control Systems Division, The Sparks-Withington Co., Jackson, Mich.



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The Oakite Saniseptor, Model 562, a compact, portable piece of equipment which couples directly into the plant's hot water line and automatically mixes hot water and detergent and delivers hot solution

through a nozzle is offered as the latest answer to the problems of cleaning food plant areas that are hard to get at for cleaning by hand. The Saniseptor consists of a seamless, cold rolled steel detergent tank, equipped with a water hose connection to the hot water supply, a syphon breaker, solution and water control valves. The unit, empty, weighs 25 pounds, and has a capacity of approximately 15 pounds of detergent, sufficient under normal conditions for several hours of cleaning. Address Oakite Products, Inc., 19 Rector St., New York 6, N. Y.

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Frozen foods, produce, paper products, and soft goods of all kinds are being packaged quickly and economically with the Tele-Sonic bag filling machine built by Tele-Sonic Packaging Corp., 208 W. 27th St., New York 1, N. Y. Models range in cost between $225.00 and $500.00.

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Tests conducted by the USDA show that fruit treated in a Dowicide A-Hexamine solution arriving from Florida in mesh bags had only 0.3 percent total decay. On the other hand, untreated citrus had as high as 12.6 percent decay. The treatment has been cleared by the USDA and FDA as a useful deterrent to the traditional enemies of citrus—stem-end rot and blue mold. The active ingredient, Dowicide A, has proven in tests to be capable of reducing decay in citrus up to 85 percent. Developed by the Florida Citrus Experiment Station with the cooperation of the Florida Citrus Commission, the USDA, and The Dow Chemical Co., Midland, Mich., the treatment is now in use by numerous Florida packing houses.

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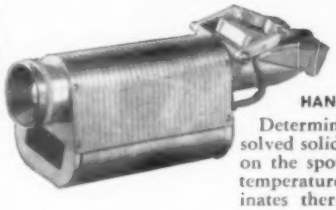
For the first time in the 60-year history of the crown industry, crown size has been changed via a shorter metal skirt combined with a plastic liner. Developed by the Bond Crown and Cork Division of Continental Can Co., the new Triple-Seal Custom Crown, right above, because of its saving in side metal, offers greater economy to bottlers of beer and carbonated beverages. The new crown seals bottles and protects beer, ale, and highly carbonated beverages as well as the standard size precision-molded plastic lined crown—offering consistent, uniform pressure retention. While it does have a shorter metal skirt, the Triple-Seal Custom Crown has the same thickness of plastic liner as in the standard size crown, plus the essential "squeegee" action of the triple rings. Use of the new crown requires only slight modifications in crowners and chutes at bottler plants, involving only a nominal expenditure. The liner has satisfactory flavor and odor properties, and is unaffected by the contents of the bottle.

Also from Continental comes word of these other developments: 1) Formation of a new company, Cochran Continental Container Corp., to be owned equally by Cochran Foil Co., Louisville, Ky., and Continental, which will combine the facilities and organization of the Cochran Products Division, one of the original and largest manufacturers of aluminum rigid foil containers, and those of Continental. 2) Construction of a super-modern new metal can plant in the borough of Queens in New York City for the manufacture of beer cans. Can production is expected to commence in the spring of 1957. 3) Acquisition of Canadian Crown Cork Co., Ltd., marking the first entry of a metal container company in Canada into the crown cork field. 4) Agreement in principle with Robert Gair Co., Inc., manufacturer of shipping containers and cartons, on the basis for merger of the two enterprises, subject to the usual checks of all business and legal matters.

Make Your Work Easier

with these QUALITY INSTRUMENTS

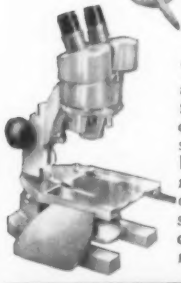


HAND REFRACTOMETER

Determines percentage of dissolved solids, especially sucrose, on the spot, instantly! Built-in temperature compensation eliminates thermometers and temperature correction tables. Built-in light source and leather carrying case make instrument portable, useful anywhere.

ABBE REFRACTOMETER

The quality control instrument for determination of purity and total dissolved solids in food products. Available with standard Abbe, Sugar and High Index scales.



STEREOSCOPIC MICROSCOPE 25LF

To detect impurities and adulterants in food. Long working distance—three-dimensional image—inclined binocular body. Removable base allows examination of large specimens. Accommodates ungraduated mechanical stage.

NEW BACTISTAR MICROSCOPE 4BU-HYZ

Permits rapid estimate of number of bacteria in fluid milk. Factory precalibrated field offers quickest count due to permanent field sizes.

DARKFIELD QUEBEC COLONY COUNTER

For estimating bacterial concentration. Comfortable to use, easy on the eyes — glareless indirect light floods the specimen from all angles. Controlled magnification achieved by 1.5 lens which completely covers the culture.

Please send me information on

☐ Colony Counter ☐ Hand Refract.
☐ Abbe Refract. ☐ 4BU-HYZ
☐ 25LF

Name .....

Address .....

City ..... State .....

American Optical — INSTRUMENT DIVISION BUFFALO 15, NEW YORK

Increased wetting properties and greater cleansing power are features of Pennsalt Chemicals' improved General Manual Kleanser now on the market. The farm and dairy cleanser has been reformulated to include nonionic and anionic wetting agents and additional polyphosphate content, greatly increasing its effectiveness, particularly in hard water areas. New GMK also has been completely dedusted for greater ease of handling. The product is available in 5-, 10-, and 25-lb. farm packages and 125- and 350-lb. bulk sizes, at no increase in price. The firm's address is 3 Penn Center Plaza, Philadelphia 2, Pa.

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A new miniature type vertical scale indicator, manufactured by Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa., is designed to provide a compact, easily read instrument with minimum price and adequate performance as important features. Designed as a semi-null balance, low cost servo-type indicator for use with differential transformers (ATCOTRAN) and resistance bulb (also thermister) inputs, it is claimed to be much more accurate and positive than a meter type instrument. The semi-null balance circuit minimizes voltage variation and does not require sola or other voltage stabilizing devices. A "fail safe" feature permits the pointer to drop to zero when the amp. fails or when the ATCOTRAN differential transformer circuit opens up.

The firm also offers a compact Automatic Temperature Control Series 6101 D Demodulator designed to supply regulated current to differential transformers (ATC series 6208 M ATCOTRANS) and convert their input to D.C. for use with Micrometers and D.C. recording potentiometers. The unit may be located up to 1000 feet from the transmitter (on a 4-wire cable), and several thousand feet on 2-wire D.C. A calibrating circuit permits testing of the unit at any time without disturbing the transmitting device. Variations in the D.C. transmission line resistance may be compensated for by means of the same calibrating circuit. No vacuum tubes or choppers are used, thereby eliminating the usual periodic replacement of these parts.

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A new series of SOLI-TIE Pressurizing Machines and Fasteners for high speed compressing and sealing of boneless meats in fibrous casings is announced by Vac-Tie Fasteners, Inc., 1140-1146 E. Jersey St., Elizabeth, N. J. Numerous design improvements have enabled the firm to lower machine costs by one-third and still maintain all the operating features for which the machines are famous. SOLI-TIE Fasteners are leak-proof, corrosion proof, and can be supplied in a variety of colors for improved product recognition and positive coding of perishables.

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A new line of industrial gloves featuring a new leather with exceptional wearing qualities is announced by Wearhide Glove Co., Rockford, Mich. The gloves are extremely flexible for complete freedom of movement, due to a special tanning process. This process also retains the tremendous resistance to abrasion found in the natural Shell Cordovan Horsehide from which the glove leather is split. Sold through industrial distributors only, the gloves are available in safety cuff, gauntlet, and knit wrist patterns. All styles have canvas backs. Names of distributors available on request.

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Two-and-one-half barrels of scrap metal is compressed into this compact 12" by 12" by 12" briquette by the SCRAP-O-MATIC, manufactured by Balemaster Division, East Chicago Machine Tool Corp., East Chicago, Ind. Bales weigh from 40 to 80 pounds, and are easily stored until disposed of.

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A new Hi-Strength pressure-sensitive flatback masking tape has been developed by Permacel Tape Corp., New Brunswick, N. J. Designated Permacel 728, it has a 4-mil rope paper backing in an off-white color. The backing has been specially treated to give the tape high tear resistance coupled with thinness and high tensile strength. Among uses recommended are heavy duty packaging applications when extra strength is needed. Another important function is holding of doors, lid covers, trays, and other parts of appliances during shipping. Of special note to appliance manufacturers are the factors of stain resistance and heat resistance built into the new tape. It is available in widths from ½" to 4", and 60 yards in length.

An anti-skid coating, Resyn 32-3415, is offered by National Adhesives, Division of National Starch Products Inc., 270 Madison Ave., New York 16, N. Y., as a remedy for shipping containers that skid during palletizing and stacking. Applied by spray nozzles to the bottoms of cases as they leave the case sealer, the coating dries almost instantaneously in an invisible film. Further information may be obtained from any of the company's offices, located in all principal cities.

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National Adhesives also announces its Soft Seal Adhesive for use as a non-tear case sealing glue. The material, which can be applied by all standard case sealing equipment, provides a safe bond during transit and storage, yet the flaps may be readily opened by a sharp upward pull. This easy-opening feature permits use of regular corrugated cases without special easy-opening attachments.

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Tetra Pak, a Swedish carton for liquids, will be promoted in the U. S. by Crown Zellerbach Corp., 343 Sansome St., San Francisco, Calif. The container is formed and filled in one operation, and is said to reduce packaging costs of a single serving up to 50 percent. The paper unwinds from its reel, comes down into a machine as a vertical tube, is heat-sealed, filled, and then heat-sealed below the level of the liquid. Tetra Paks are in use in 22 foreign countries.

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A new leak-proof valve which employs a newly-developed plastic seal of outstanding durability to achieve a permanent leak-proof quality is the product of U. S. Valve Corp., 831 Bond St., Elizabeth 4, N. J. The valve has a working pressure of up to 435 psi, and remains completely leak-proof under pressure of 725 psi. It permits no drop in line pressure. No maintenance or lubrication is required after installation. It is designed to operate at temperatures of up to 250° F.

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The Commonwealth Engineering Company of Ohio has developed a patented process whereby the **waste product of the citrus fruit rind is extracted and converted into a vegetable dye.** The dye rapidly and effectively colors the whole orange, whose exterior is irregular in color—thereby giving it the appearance of completely ripened fruit. The firm will license the patent to manufacturers. Further information may be obtained by writing the company at 1771 Springfield St., Dayton 3, O.

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All types of crawling and flying insects are controlled by the streamlined Galitrol Vaporizer, according to General Industrial Co., 5742 N. Elston Ave., Chicago 30, Ill. Guaranteed to operate 24 hours a

the greatest advance in meat seasoning

Scientifically manufactured MAGNA SPICE CONCENTROLS have modernized the seasoning of meats by making available the true flavor components of herbs and spices in the most concentrated form known to Science . . . yet easily processed in your own plant. All the flavor is released immediately. Each batch of your product is uniformly and identically seasoned.

- **Out perform crude herbs and spices.**
- **Easy to measure — easy to mix.**
- **No spoilage.**
- **Cut seasoning costs up to 40%.**

Write for the new MM&R booklet — "The Greatest Advance in Meat Seasoning."

MAGNUS, MABEE & REYNARD, INC.

Since 1895 • One of the World's Greatest Suppliers of Essential Oils and Flavors

16 DESBROSSES STREET, NEW YORK 13, N. Y., U.S.A.
221 NORTH LaSALLE STREET, CHICAGO 1, ILL., U.S.A.

day for one year, the unit effectively covers an area of 15,000 cu. ft. Operates on AC or DC current, with addition of Galin Crystals. Available at $8.95 each.

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A new diaphragm-type solenoid valve designed to meet the need for an "off the shelf" multi-purpose valve is being produced by General Controls Co., Glendale, Calif. Because of its diaphragm action and full flow ports, the new valve, known as the K-181, is capable of handling large capacities with a minimum pressure drop, thus making it suitable for shutoff control of a large variety of liquids and gases over a wide range of operating pressures up to 250 psi. The K-181 is available in $\frac{3}{8}$" and $\frac{1}{2}$" ips, and is offered in 2 basic models. Standard models handle a wide range of general applications using air, water, gases, or light oils. Hot water models are particularly suited for controlling water at temperatures up to 200° F. for use on coffee makers, hot chocolate machines, soup makers, laundry machines, and various types of vending equipment.

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A new model of its Vapor Fractometer (gas chromatography device) which permits fast analysis of gases and liquids boiling up to 300° C. at operating temperatures up to 225° C. is announced by the Instrument Division of Perkin-Elmer Corp., Norwalk, Conn. Designated the Model 154-B Vapor Fractometer, the instrument incorporates several other new features. A precision liquid sampling system also has been developed as an accessory for the unit.

. . . *the literary corner*

The new edition of the Florasynth catalog provides a detailed listing of products and their suggested uses for manufacturers of foods, confectionery, beverages, extracts, pharmaceuticals, cosmetics, and soaps, and for industries using flavorings, perfume compounds, aromatic chemicals, and essential oils. Direct requests, on company letterhead, to Florasynth's executive offices at 900 Van Nest Ave., New York 62, N. Y.

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Niagara Blower Company's Bulletin 132, "Sectional Aero Heat Exchanger," illustrates and explains the functions of new equipment to provide cooling of liquids in industrial plants independent of a large supply of cooling water and with additional savings of installation and operating expenses. The firm's address is 405 Lexington Ave., New York 17, N. Y.

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"Urgent Need for Better Cartoning," an article by Mr. Wm. J. Hoover, assistant to the director, Refrigeration Research Foundation, and appearing in the June 1956 issue of *Food Engineering*, is available as a reprint from the Foundation, 12 N. Meade Ave., Colorado Springs, Colo.

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Fritzsche Brothers Inc., 76 Ninth Ave., New York 11, N. Y., offers its latest wholesale price list, dated July 1956, to companies whose purchases are in wholesale quantities.

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"The House of Magnus" (Food Edition), published by Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y., reports that a new mushroom-type food may become available commercially as a result of a project now underway at the University of California on the production of edible fungi in fermentation tanks. The process is similar to that used in large-scale penicillin production. MM&R will be pleased to put readers of *Food Technology* on its "House of Magnus" mailing list.

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The following literature is available from National Confectioners' Assn., 221 N. LaSalle St., Suite 426, Chicago 1, Ill.: 1) "Progress in Candy Research," Report No. 30, 24 pages, covering the period June 1, 1955, to June 1, 1956, and prepared by Dr. L. F. Martin, head, Sugarcane Products Section, Southern Utilization Research Branch, USDA; 2) "Application of Research to Problems of Candy Manufacture," by Dr. L. F. Martin, reprinted from *Advances in Food Research*, Vol. VI, 1955 (Single copies of this book, which ordinarily costs members $2.50 each, are being made available to schools of food technology as an aid in teaching a course in candy technology.); 3) limited copies of technical addresses delivered at the NCA's recent 73rd annual convention in Boston.

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A special issue of *Norelco Reporter*, March-September 1956, is devoted to X-ray Spectroscopy. For a copy of this valuable 96-page publication, write North American Philips Co., Inc., Instruments Division, 750 S. Fulton Ave., Mount Vernon, N. Y.

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Torit Mfg. Co., 292 Walnut St., St. Paul 2, Minn., has issued a standard envelope-size booklet titled "You Can Solve that Dusty Cost Problem" that describes the principles of unitized dust collection, its advantages and savings. Write Department KP for Booklet No. 56.

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A rundown of 550 chemical additives for foods and their usage levels is contained in a special report issued by The National Academy of Sciences and National Research Council, available from the NAS-NRC Publication Office, 2101 Constitution Ave., Washington 25, D. C. Price $2. So reports *Fatty Acid News Digest*, published by Fatty Acid Division, Association of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y.

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Dry blending and heat transfer equipment for the chemical and process industries is described in a revised, enlarged catalog offered by The Patterson-Kelley Co., Inc., East Stroudsburg, Pa. Catalog No. 14 covers the following: 1) laboratory and production models of standard and special Twin-Shell, double-cone, and ribbon blenders; 2) synthetic resin

pilot plants of standard design; 3) standard and special process heat exchangers in various metals and applications; 4) the Lever-Lock quick-opening door for pressure vessels and heat exchangers.

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"Now . . . J-M Rock Cork Refrigeration Insulation Stops Flame," an illustrated 4-page folder emphasizing Rock-Cork's new incombustible qualities, has been issued by Johns-Manville, 22 E. 40th St., New York 16, N. Y. Besides the new fire safety, the folder also explains such other advantages as sanitary qualities, high moisture resistance, low conductivity, long service life, high structural strength, immunity to rot, and ease of installation.

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Glycerine has a marked influence on the reaction rates of diffusion controlled chemical reactions, it has been discovered by Dr. Gerald Oster, associate professor of polymer chemistry at the Polytechnic Institute of Brooklyn. In such reactions—designated diffusion-controlled because their rate is determined by the speed of diffusion of the reactants toward one another—glycerine increases the *local* viscosity of the reaction solution, Dr. Oster's experiments show, and hence influences the velocity of reaction. Other thickening agents such as gelatin, polyvinyl alcohol, polyacrylamide, etc., he found, increase only the macroscopic viscosity of the solution appreciably, and have no effect on the reaction rate. (Macroscopic viscosity refers to the viscosity of the entire solution; local or true viscosity to the viscosity of the medium immediately surrounding the molecules in solution.) The above was reported in *Glycerine Facts*, June 15, 1956, published by Glycerine Producers' Assn., 295 Madison Ave., New York 17, N. Y.

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Dry Processing Equipment is the subject of a new 8-page booklet available from Sturtevant Mill Co., 150 Clayton St., Boston 22, Mass. The title is "Sturtevant Dry Processing Equipment—the 'Open Door' to Lower Operating Costs over More Years." Stated briefly, the unique "open door" feature of Sturtevant equipment means that the vital parts of any unit are accessible by "one man in one minute." The literature also discusses Sturtevant's unusual "Co-operative Engineering Plan." This permits a manufacturer with a problem to take advantage of the company's experience either at no cost or at a charge proportional to value received.

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Layne water well systems, Layne oil and water lubricated Vertical Turbine Pumps, special water well drilling, service work, shutter screen irrigation wells and pumps, water and well treatment for rehabilitating water sources, and other phases of water development for industry and municipalities are described in Bulletin No. 100, available from Public Relations Department, Layne & Bowler, Inc., Memphis, Tenn.

◆ ◆ ◆

Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., announces inauguration of Quality Control and Applied Statistics Abstracts, a monthly looseleaf abstract service covering the world literature on quality control, operations research, and industrial applications of statistical methods of all kinds. More than 400 journals will be scanned for articles that present new information in the field, and the abstracts will be sufficiently comprehensive to show the significant contribution of each article, so that it usually will be unnecessary to consult the original paper. The Abstracts will consist of one volume of about 1,000 pages yearly, divided among 12 issues, beginning in June 1956. Subscription price is $60 per volume.

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Two bulletins for the food and chemical process industries are available from Rietz Mfg. Co., Santa Rosa, Calif., and West Chester, Pa. No. R-507 deals with applications of various models of Disintegrators to fine or coarse disintegration and/or mixing of wet dry materials. No. P-508 discusses applications of different models of Prebreakers and Mastigrators to the size reduction and/or mixing of bulky solids and of solid-and-liquid streams and the extrusion of pasty materials.

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What is reported as the first literature ever produced on large diameter, thin-wall tubing has been prepared by Superior Tube Co., 1697 Germantown Ave., Norristown, Pa. Known as Data Memorandum No. 4, the literature describes tubing in sizes with

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outer diameters from $\frac{3}{8}$" to $2\frac{1}{2}$", and with wall thicknesses of .035" and less. Superior produces this tubing in both the seamless and Weldrawn grades for application to a wide variety of products. The Weldrawn is fusion welded from strip, and cold drawn to size. Typical applications listed include fuel and oil lines, heat exchanger and cooling system tubing, flexible metal hose, hydraulic brake cylinder lines, and envelopes for such products as fractional horsepower motors, stators, electron power tubes, and well-logging instruments.

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Copies of a new 16-page brochure on the firm's line of laboratory instruments, and entitled *Lab-ORATORY*, are available from Schaar and Co., 754 W. Lexington St., Chicago 7, Ill.

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"A Survey of World Literature on Coffee, 1954," by Ernest E. Lockhart, scientific director of The Coffee Brewing Institute, and Fred B. Bloomhardt, librarian of the Concord (Mass.) Public Library, has been released by the Institute, 551 Fifth Ave., New York 17, N. Y. The free publication is the fourth in the Institute's series.

◆ ◆ ◆

A basic patent on preparation of the chemically modified fats known as acetoglycerides has been granted and now is available for licensing without cost. The patent, No. 2,745,749, "Glyceridic Mixtures Exhibiting Unique Properties and Process for Their Production," was granted to Reuben O. Feuge, Earl J. Vicknair, and Klare S. Markley, as a result of work done at the Southern Utilization Research Branch, USDA. Copies may be purchased for 25c each from the U. S. Patent Office, Washington, D. C.

Also available are technical papers describing results of investigations of the preparation, properties, and uses of acetoglycerides carried on at the Southern Laboratory for several years. Persons desiring to do so, may obtain these reprints without cost by writing Southern Utilization Research Branch, USDA, 1100 Robert E. Lee Blvd., New Orleans, La., indicating the special phase of the acetoglyceride work in which they are interested.

. . . *the human element*

Mr. Jos. F. Stilling, recently with Reynolds Metals Co., has been appointed director of the materials handling program of Continental Can Co., 100 E. 42nd St., New York 17, N. Y. He will coordinate and take charge of materials handling activities for the Metal Division of the company, working through its production engineering staffs.

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Mr. Wm. A. W. Krebs, Jr., has been elected vice president of Arthur D. Little, Inc., 30 Memorial Dr., Cambridge, Mass. Mr. Krebs, a member of the Massachusetts and New York Bars, presently represents the firm as a director and secretary of its affiliate, Nuclear Metals, Inc., and has served the company as a consultant in the general area of his professional field. He will continue as visiting associate professor at the MIT School of Industrial Management. For the last several years, he has been executive secretary of the New England Committee on Atomic Energy.

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. . . Shulton's Klingel

Appointment of **Mr. Harry Klingel** as director of research of the Fine Chemicals Division of Shulton, Inc., has been announced by Mr. Richard E. Brainard, vice president in charge of the division. Shulton's Fine Chemical Division has plants in Clifton and Newark, N. J., producing chemical elements for use in the drug, toiletries, food, and tobacco industries. Mr. Klingel joined Shulton, Inc., in 1955 when the company acquired A. Maschmeijer, Jr., Inc.

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On May 1, **Mr. Frederick A. Gilbert** succeeded Dr. **Max E. Bretschger** as president of Becco Chemical Division of Food Machinery and Chemical Corporation, Buffalo, N. Y. Dr. Bretschger will continue to act as senior technical advisor for the Division.

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Rodney Hunt's Earl Harris

Mr. Earl F. Harris has been elected president of the Rodney Hunt Machine Co., Orange, Mass. Joining the firm in 1946, following military service in China, he became vice president in 1947 and executive vice president in 1952. **Mr. Carl C. Harris,** president since 1938, will continue to serve the company as board chairman.

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National Starch Products, 270 Madison Ave., New York City, announces the following executive appointments: **Mr. Robert A. Bintz,** assistant vice president, to plant manager of the Indianapolis plant and a director of the company; **Mr. J. Donald George,** superintendent of production at Indianapolis, to assistant director of manufacturing, with headquarters at Plainfield, N. J.; **Mr. Glenn K. Smith,** superintendent of engineering at Indianapolis, to general superintendent of the Indianapolis plant.

. . . Bintz of National Starch

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Mr. Arthur T. Schramm, a member of IFT, has succeeded Mr. Frank W. Green, retired, as manager, Certified Colors, National Aniline Division, Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Mr. Paul L. Davies has been elected chairman and chief executive officer of Food Machinery and Chemical Corp., San Jose, Calif. Succeeding Mr. Davies as president is **Mr. Ernest Hart,** formerly executive vice president in charge of chemical divisions. **Mr. John D. Crummey,** who has served as chairman of the board of directors since his retirement from active management in 1946, was elected honorary chairman. Other new executive appointments include: **Dr. Carl F. Prutton,** executive vice president in charge of chemical divisions; **Mr. James M. Hait,** executive vice president; **Mr. John D. Fennebresque,** executive vice president; **Mr. Jack M. Pope,** financial vice president; and **Mr. Alfred T. Loeffler,** vice president. Executive vice president in charge of machinery divisions is **Mr. Ben C. Carter.**

. . . FMC's Davies

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. . . Fritzche's Cassullo

At a recent meeting of the board of directors of Fritzsche Brothers, Inc., New York City, **Mr. John L. Cassullo,** treasurer, was elected to the presidency of the 85-year-old essential oil and aromatic chemical firm to succeed Mr. John H. Montgomery, its retiring head. At the same meeting, **Mr. Gustav A. Wohlfort** and **Mr. Ellis F. Merkl** were elected treasurer and assistant treasurer, respectively.

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Dr. Georg A. Borgstrom, of Gothenburg, Sweden, has been named to head the fruit and vegetable phase of the food technology program at Michigan State University. He has been professor of food preservation technology at the Technical University of Gothenburg and head of the Swedish Institute of Food Preservation Research.

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Recent appointments at American Can Company include those of **Mr. Daniel T. McFadden,** former manager of sales of the firm's Atlantic Division, to assistant to the general manager of sales; **Mr. W. S. Beard,** former assistant division manager of sales, to manager of sales for the Atlantic Division; and **Mr. L. G. Weiner,** former department supervisor of sales in the company's Central Division, to assistant to the manager of sales.

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Mr. Boyd B. Mahon, Jr., has been appointed assistant sales manager, and **Mr. Harold E. Huber** has been appointed manager of technical sales in the Votator Division of The Girdler Co., division of National Cylinder Gas Co., 224 E. Broadway, Louisville 1, Ky. The division designs and manufactures processing apparatus, and designs and erects complete processing plants for the fatty oil, food, and chemical industries.

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. . . Leonhardt of D&O

Newly elected president of Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y., is **Mr. Frederick H. Leonhardt, Jr.** Others in the new slate of officers are: **Mr. R. V. Behrens,** vice president and treasurer; **Mr. V. H. Fischer,** vice president; **Mr. J. P. Bauer,** vice president; **Mr. E. M. Behme,** secretary; and **Mr. Louis Yound,** assistant treasurer.

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Four additions to the technical staff of Evans Research and Development Corp., chemical consulting laboratory of New York City, were announced by Dr. Eric J. Hewitt, vice president. The new staff members are: **Mr. Raymond Albrecht,** from St. John's University; **Mr. Herbert Kaplan,** from Cornell University; **Mr. Paul Mech,** from Pepsi-Cola Co.; and **Miss Pauline Sanders,** from Helene Curtis.

LOOK TO TWITCHELL FOR

POWDERED CARAMEL COLOR

First introduced over 10 years ago, Twitchell's Caramel Color is now used by leading food manufacturers throughout the country. It is a clean, natural coloring, completely made from dextrose. Twitchell's Caramel Color is particularly suited for use in dry food preparations to produce a rich color, from a light tan to dark brown.

Typical Uses

- Powdered Desserts
- Dehydrated Soups
- Dry Cake Mixes
- Bouillon Powders
- Powdered Coffee and other beverages
- Powdered Gravy Seasonings

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. . . Mr. Cryns

Mr. Jos. L. Cryns, 70, widely known baked products technician at the Army's Quartermaster Food and Container Institute in Chicago, died June 20 after a brief illness. Born in Germany, Mr. Cryns became an American citizen in 1935. His skill as a technologist resulted in his receiving the coveted Quartermaster Research Directors' Award in 1952. In addition to his development of "wheat base," he was largely responsible for the canned baked items which have become essential parts of modern operational rations.

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Dr. James A. Bralley has been named director of research for the A. E. Staley Mfg. Co., processors of corn and soybeans, Decatur, Ill. In announcing Dr. Bralley's appointment, Dr. Thos. L. Gresham, vice-president in charge of research and development, said it is another step in continuing expansion of the Staley research program which started early this year. Dr. Bralley has been with Rohm & Haas Co., Bristol, Pa., for the last 10 years.

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. . . Paul Steinke to Paul Lewis

Paul Lewis Laboratories, Inc., 4253 N. Port Washington Ave., Milwaukee 12, Wis., announces addition of **Dr. Paul Steinke** to their staff as head of the Bacteriology Department. For the past 5 years, he has been with Chain Belt Co., Milwaukee, as bacteriologist and supervisor of the Organic Laboratory.

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Mr. Wm. R. McDonald has been appointed director of advertising and public relations of Crown Cork & Seal Co., Inc., on the staff of Mr. Robert F. Duemler, vice president and director of sales for the firm. Mr. McDonald formerly was advertising manager of the elevator division, Westinghouse Electric Corp.

. . . Cotterill . . . hail Columbia!

◆ ◆ ◆

Dr. Owen S. Cotterill, since 1951 assistant professor of poultry products technology at Iowa State College, Ames, has been appointed assistant professor of poultry husbandry at the University of Missouri. Dr. Cotterill is a member of IFT.

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Mr. Wm. A. Hadfield of the Pennsalt Chemicals technical staff, retired on July 31 from a 41-year career as one of the country's leading sanitarians. Widely known throughout the milk and food industries, Mr. Hadfield pioneered in the field of chlorine sanitation on the farm and in dairy plants.

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Election of Mr. Chester F. Smith to the Board of Directors of van Ameringen-Haebler, Inc., was announced recently by Mr. Chas. P. Walker, president of the New York perfume and flavor materials firm. Mr. Smith formerly was president of Esso Standard Oil Co., and is a director of Standard Oil Company (New Jersey), where he had served as vice president. In 1949 and 1950, he served as vice president of the Refining Division of the American Petroleum Institute. He has been decorated by the French Government as a Knight of the Legion of Honor, and by the Belgian Government with the Order of Leopold.

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Mr. Madison H. Lewis was re-elected president of the Dairy Remembrance Fund for a one-year term at the group's recent annual meeting. Also re-elected were **Mr. E. J. Mather,** vice president; **Mr. E. B. Lehrack,** treasurer; **Mr. Robert Rosenbaum,** secretary and executive director; and **Mrs. Lois Lientz,** assistant treasurer.

. . . ***meeting hall and conference room***

At the recent 73rd Annual Convention of the National Confectioners Association in Boston, additional research funds were made available by the Brewers Yeast Council, Inc., to a joint cooperative research project with the NCA and the USDA Candy Laboratory in New Orleans on the use of brewers dried yeast in prolonging shelf life of candy. In the photograph, Mr. Frederick W. Haffenreffer, second from left, of Haffenreffer & Co., Inc., Boston brewers, who is a member of the BYC board of directors, presents a check for $500 to Mr. John Henry, far right, chairman of the NCA Research Committee and president of DeWitt P. Henry Co., Philadelphia confectioners. Looking on are Dr. L. F. Martin, far left, director of the USDA Candy Laboratory, and Mr. P. P. Gott, president of the National Confectioners Assn. Brewer's dried yeast has been found to be a natural, nutritive candy ingredient that not only supplies protein and B vitamins, but acts as an antioxidant which stabilizes animal fats, and particularly dairy butter in candies. BYC headquarters is located at 605 N. Michigan Ave., Chicago 11, Ill.

On May 31, 1956, a new regional section of the Association of Food Industry Sanitarians was formed. Representatives from numerous concerns located in the Minneapolis-St. Paul area attended. It is hoped that the membership of the section, as yet not officially named, will include individuals from Minnesota, Iowa, Wisconsin, North Dakota, and South Dakota. Officers elected were: president—Mr. Walter W. Johnson, King Midas Flour Mills, Minneapolis; vice president—Mr. Dom. Frank, Gamble Robinson Co., Minneapolis; secretary-treasurer—Mr. Wayne D. Stahl, E. H. Leitte Co., Minneapolis.

The annual meeting of the AFIS for 1956 will be held in Monterey, Calif., at the Casa Munras Hotel on October 24-26. The Association also is one of the sponsors of the forthcoming 1st International Sanitation Maintenance Show & Conference, to be held in the New York Coliseum October 14-16, 1956.

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Who and what influences growers to buy and use agricultural chemicals will be one of the major topics to be discussed at the 23rd Annual Meeting of the National Agricultural Chemicals Association in Spring Lake, N. J., September 5-7. The meeting also will feature a presidential address by Mr. W. W. Allen, manager, Agricultural Chemical Sales, The Dow Chemical Co.; a report on entomological research by Dr. E. F. Knipling, chief, Entomological Research Branch, Agricultural Research Service, USDA; and a talk on the "Industry Outlook" by Mr. J. V. Vernon, president, Niagara Chemical Division, Food Machinery & Chemical Corp. More than 500 leaders in the agricultural chemicals industry, in government, and in agricultural communications are expected to take part in the meeting, which also will include panel discussions of the effect of the new highway expansion program on the use of pesticides and of the latest developments under the Miller Pesticide Residue Amendment.

. . . *building up and branching up*

To provide on-the-spot, complete service to the large eastern food and chemical processors that account for more than three-quarters of its business, Rietz Mfg. Co., Santa Rosa, Calif., is constructing a fully-equipped eastern headquarters on a 9-acre site near West Chester, Pa. Pending completion of its new buildings, Rietz now is operating out of temporary quarters in the Farmers and Mechanics Building in West Chester.

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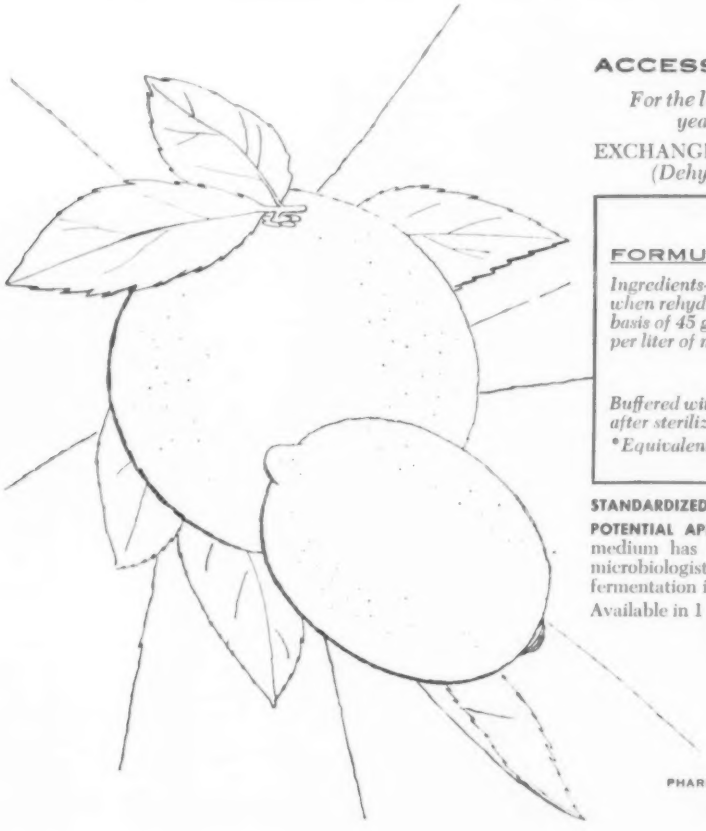
American Can Company started production at its new plant in Salem, Ore., on June 20. The plant, which will serve the nation's principal area for packing Blue Lake string beans, is located in the Willamette Valley, and is Canco's 12th production center on the West Coast. Governor Elmo Smith of Oregon

(Continued on page 69)



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For the luxuriant growth of all lactic acid bacteria yeasts and molds assured by the use of

EXCHANGE BRAND ORANGE SERUM AGAR #77
(Dehydrated) a Complete Culture Medium

FORMULA

Ingredients—when rehydrated on basis of 45 grams per liter of medium.

Orange juice serum solids	12.6g*
Agar (dry basis)	15g
Peptone	10g
Yeast hydrolysate	3g
Reducing sugars, total	8g
Sucrose, total	6g
Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

POTENTIAL APPLICATION—Orange Serum Agar as an all-purpose medium has a wide application to the bacteriologist and microbiologist in the milk, fruit, pickling, food, bottling and fermentation industries.

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Institute of Food Technologists

THE PROFESSIONAL SOCIETY OF FOOD TECHNOLOGISTS

The Institute of Food Technologists numbers among its active members leading scientists, technologists and engineers in the field of Food Technology.

The Institute invites your professional association with this select group of scientific and technological workers. Only those who are qualified by education, special training, or experience are extended this invitation.

Food Technology may be defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Scientists, technologists and engineers engaged in Food Technology, executives, officials and supervisors under whose jurisdiction Food Technology operations are conducted, research investigators, teachers, and others working in the field of Food Technology, will find membership in the Institute worth many times its modest cost.

If you can meet the qualifications for membership, you owe it to yourself and to your business or profession to become a member.

OBJECTIVES

The Institute is a non-profit, professional, educational association to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; it stimulates investigations into technological problems arising therein, it provides a medium for presenting and discussing the results of such investigations; it stimulates and provides means for the free interchange of technological information and ideas among food technologists; it promotes recognition of the role of food technologists in the technical direction of operations in these fields; all of these activities have the ultimate objective of providing better and adequate foods for mankind.

ORGANIZATION AND PROGRESS

Organized July 1, 1939, at Cambridge, Mass., with a membership of less than 100, the Institute has grown to more than 4,000 (1954). It is world-wide in scope, with members in North, Central, and South Americas, the Scandinavian countries, England, Holland, Germany, France, India, Australia, and New Zealand.

MEMBERSHIPS

Professional Members. Any person who is ethically qualified, and who has had training and experience in food technology, or any person who in the opinion of the Council is recognized as distinguished in the contributing sciences as they apply to foods, shall be eligible to be a Professional Member of the Institute. The minimum training which shall qualify a candidate for eligibility for Professional Member is, in general, graduation from a college, university, or similar institution in which he has majored in one or more of the sciences or branches of engineering associated with food technology. The minimum experience shall be three years experience in food technology. The Council may, at its discretion, waive any or all of the foregoing requirements in the case of a person who, thru long experience, has distinguished himself in the field of food technology.

Members. Any ethically qualified person, active in special or limited aspects of food technology, who is an administrator, director or executive under whose jurisdiction operations in food technology are conducted; or who is engaged in the dissemination of knowledge of food technology; or one whose work requires a general knowledge of the broad principles of food technology as it applies to the products, processes or equipment with which he or she is concerned; or one scientifically trained in and who has entered a career in food technology; shall be eligible to become a Member.

Student Members. Any ethically qualified person who has never been a Professional Member or Member of the Institute, who is registered as a student in an educational institution with at least Junior (third year) standing, who is a candidate for a Bachelor's or higher degree in one or more of the sciences or branches of engineering associated with food technology, shall be eligible for membership as a Student Member. This classification shall be his status only until the end of the calendar year in which he completes his schooling. When graduated and otherwise qualified as defined in the section on "Members," a Student Member may, upon application, be elected to Membership.

DUES

Professional Members and Members—$7.50 per year; Students—$2.50 per year. Dues include a subscription to FOOD TECHNOLOGY.

PUBLICATIONS

FOOD TECHNOLOGY, issued monthly, is the official journal of the Institute. It is published to advance the profession of food technology by disseminating the results of research and their practical application in industry. Contributors to its pages represent many fields of scientific and technological interest.

FOOD RESEARCH, published bi-monthly, is devoted to publication of the results of original investigations and occasional reviews in the fields of food and beverage technology, chemistry, and microbiology. FOOD RESEARCH is available to Institute members at the special rate of $7.50 per year.

REGIONAL SECTIONS

Where sufficient members (25 or more) live within commuting distance of a given point, a Regional Section may be established. Such Sections are able to hold meetings at more frequent intervals than the National group, thus affording the food technologists regular opportunities for an exchange of views and ideas with others in the area. There are presently 24 Regional Sections.

ANNUAL MEETINGS

Each year one of the regional sections acts as host to the Institute at an annual meeting. The program of this annual conference is designed to acquaint members with various phases of food production, processing and distribution, and to keep them abreast of current trends and technological developments. The speakers invited are those whose subjects will build a well-rounded program, of interest to the greatest number. Annual conferences are highlighted by exhibits of new equipment, processes and special ingredients.

AWARDS

The society administers the following awards:

NICHOLAS APPERT AWARD (Medal). Each year the Chicago Section of the Institute makes this award to a person whose contributions to the food industry make him distinguished and outstanding in the opinion of the national jury.

BABCOCK-HART AWARD ($1,000.00). The purpose of this award, made by the Nutrition Foundation, is to encourage contributions to FOOD TECHNOLOGY which will have an influence on the nutritional well-being of the general population.

FLORASYNTH FELLOWSHIP AWARD. $1,000 granted annually to a young man or woman under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in recognized educational institutions in the United States or Canada, which is conducting fundamental investigations for the advancement of Food Technology.

GENERAL FOODS FELLOWSHIP AWARDS. Three Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Committee of the Institute for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to read for a Master's Degree, will not be excluded from these fellowship grants. Each Fellowship is worth approximately $4,000.

GERBER BABY FOODS POST-DOCTORATE FELLOWSHIP AWARD. This Fellowship to promote research in some newer phase of food technology is worth $6,000.00 per annum and may be renewed for an additional year.

(Continued from page 67)

joined with Mr. R. C. Stolk, Canco's West Coast vice president, in ceremonies during which containers started moving down assembly lines geared to produce cans at 450 per minute. Mr. J. G. Griffin of Portland, Ore., an 11-year veteran of the can-making industry, has been named manager of the new plant.

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Sales and earnings of Chas. Pfizer & Co., Inc., for the first 6 months of the year were the highest for any similar period in the firm's 107-year history. Net sales of $87,194,132 were up 10% over the $79,411,049 reported for the first half of 1955. Net earnings of $9,578,517 were 17% higher than the $8,152,764 for the first 6 months last year and were equivalent after payment of preferred dividends to $1.77 per share of common stock against $1.58 in 1955. Earnings before taxes for the 6 months were $17,670,399, compared with $13,948,409 in the corresponding period last year.

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Celanese Corporation of America, 180 Madison Ave., New York 16, N. Y., has announced that the Chilean Government has approved the application of its foreign subsidiary, Celatino, S.A., for establishment of a multi-million dollar acetate yarn plant near the city of Valparaiso. The plant, the first acetate yarn manufacturing venture in Chile, will have an initial capacity of 3,000,000 pounds annually. Current plans call for it to come into operation within the next 18 months. It will be operated by a newly organized Celanese affiliate company, Celanese Chilena, S.A.

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Bell Aircraft Corp., P. O. Box 1, Buffalo 5, N. Y., has announced formation of the Bell Automation Corp., a new, wholly-owned subsidiary in Rochester, N. Y., which will specialize in the field of automatic controls and systems. First product to be introduced is the Electro-Way, an electronically controlled, continuous weighing system for the conveyor belt handling of bulk materials. Officers of the new corporation are: president—Mr. Leston P. Faneuf, vice president and general manager of Bell Aircraft; vice president—Mr. Terence M. Nolan, manager of product planning, Bell Aircraft; and secretary-treasurer—Mr. Wm. G. Gisel, secretary and comptroller of the parent company. Mr. Frank S. McCullough has been named general manager of the Rochester operation. Mr. Lawrence D. Bell, president of Bell Aircraft, is chairman of the new firm's board.

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The advertising and public relations program conducted by the sugar industry will be extended and amplified for the next 3 years, Mr. Ernest W. Greene, president of The Sugar Assn., Inc., announced recently. Expenditures will be stepped up to $750,000 a year for advertising and $100,000 a year for public relations and publicity. Principal objective of the program is to present to the public the facts about sugar's rightful place in the diet and to counteract the claim that sugar is fattening.

The Tagliabue laboratory and industrial thermometer and hydrometer division has been purchased from Weston Electrical Instrument Corporation by H-B Instrument Co., Philadelphia, Pa. Manufacturing facilities and sales offices of the Tagliabue Division, located in a new plant at 87 Sewell St., Hempstead, L. I., N. Y., initiated normal operations on August 1. Executive offices are located at 263 W. Bristol St., Philadelphia 40, Pa.

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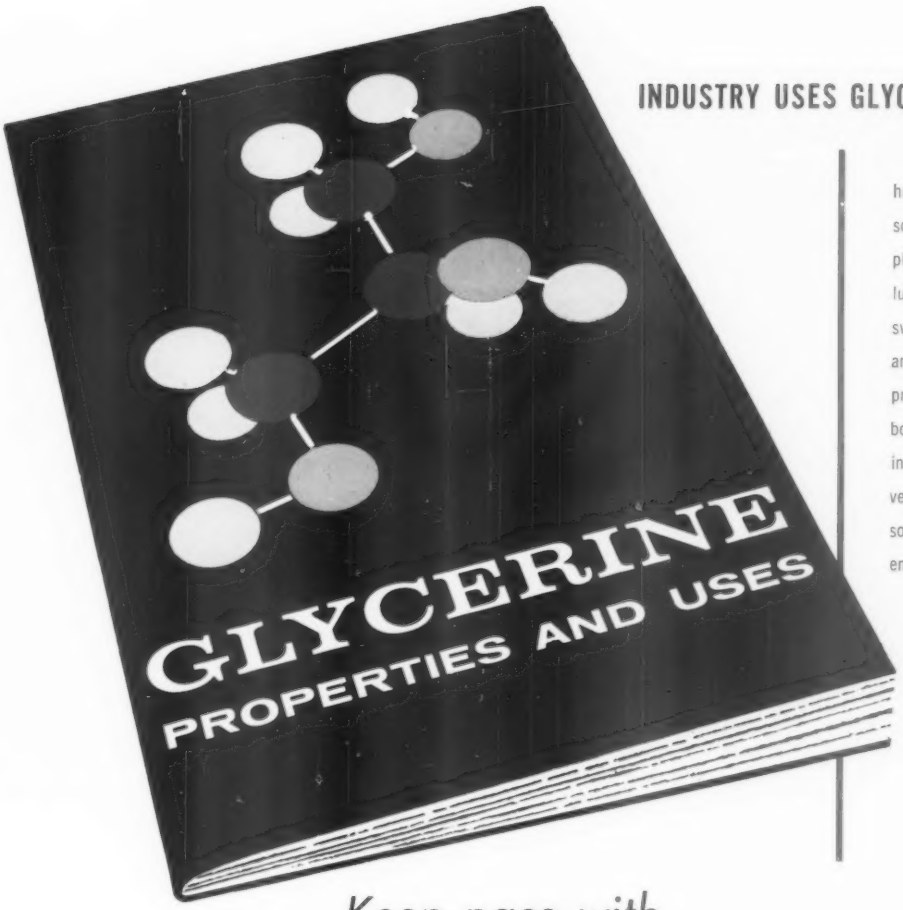

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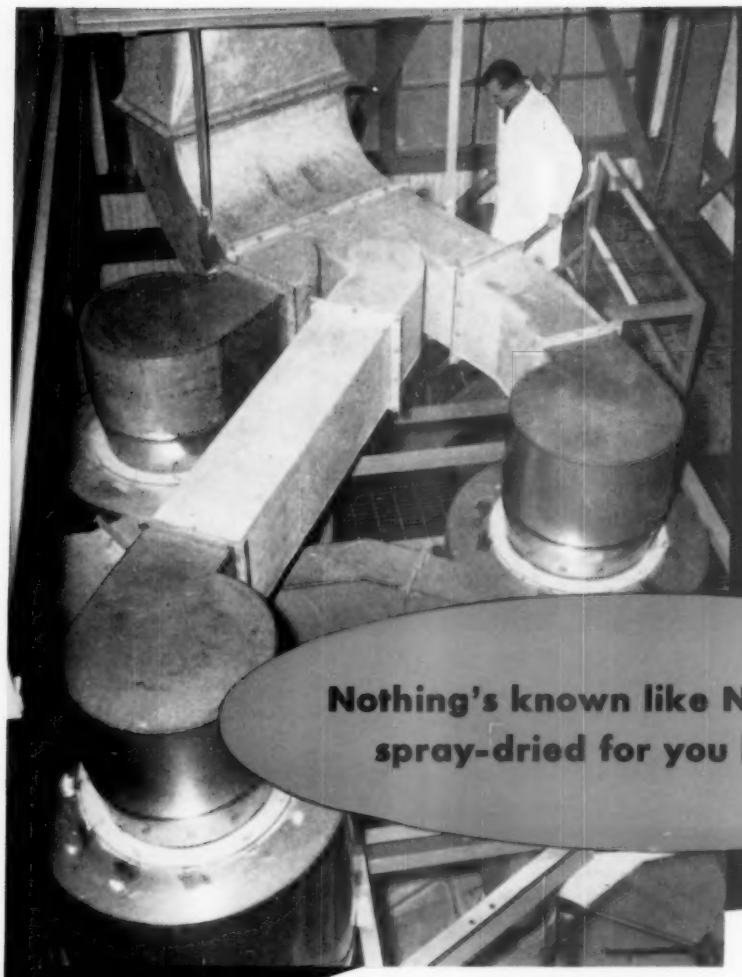

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